TRANSACTIONS
OF THE
AMERICAN FISHERIES SOCIETY

1913

TRANSACTIONS

OF THE

AMERICAN FISHERIES SOCIETY

AT ITS

FORTY-THIRD ANNUAL MEETING

September 8, 9, 10 and 11, 1913

AT

BOSTON, MASSACHUSETTS

NEW YORK, N. Y.
PUBLISHED BY THE SOCIETY
1914

Officers

1912-1913

Elected at the Forty-second Annual Meeting in Denver, Colo., for the ensuing year, including the meeting to be held at Boston, Mass., beginning September 8, 1913:

President ..... Charles H. Townsend, New York, N. Y.
Vice-President ..... Henry B. Ward, Urbana, Ill.
Recording Secretary ..... Ward T. Bower, Washington, D. C.
Assistant Recording Secretary ..... H. D. Aller, Washington, D. C.
Corresponding Secretary ..... George W. Field, Sharon, Mass.
Treasurer ..... C. W. Willard, Westerly, R. I.

Vice-Presidents of Divisions

Fish Culture ..... James Nevin, Madison, Wis.
Aquatic Biology and Physics ..... L. L. Dyche, Pratt, Kan.
Commercial Fishing ..... W. J. Hunsaker, Saginaw, Mich.
Angling ..... H. Wheeler Perce, Chicago, Ill.
Protection and Legislation ..... T. S. Palmer, Washington, D. C.

Executive Committee

Daniel B. Fearing, *Chairman*, Newport, R. I.; N. R. Buller, Harrisburg, Pa.; Ernest Schaeffle, San Francisco, Cal.; J. Quincy Ward, Frankfort, Ky.; Dwight Lydell, Comstock Park, Mich.; George W. Miles, Indianapolis, Ind.; George H. Graham, Springfield, Mass.

1913-1914

Elected at the Forty-third Annual Meeting in Boston, Mass., for the ensuing year, including the meeting to be held in New Orleans, La., beginning September 30, 1914:

President ..... Henry B. Ward, Urbana, Ill.
Vice-President ..... Daniel B. Fearing, Newport, R. I.
Recording Secretary ..... Raymond C. Osburn, New York, N. Y.
Corresponding Secretary ..... George W. Field, Sharon, Mass.
Treasurer ..... C. W. Willard, Westerly, R. I.

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Executive Committee

Jacob Reighard, *Chairman*, Ann Arbor, Mich.; N. R. Buller, Harrisburg, Pa.; J. Quincy Ward, Frankfort, Ky.; George W. Graham, Springfield, Mass.; George W. Miles, Indianapolis, Ind.; Ernest Schaeffle, San Francisco, Cal.; J. A. Dayries, New Orleans, La.

AMERICAN FISHERIES SOCIETY

Organized 1870

The first meeting of the Society occurred Decemeber 20, 1870. The organization then effected continued until February, 1872, when the second meeting was held. Since that time there has been a meeting each year, as shown below. The respective presidents were elected at the meeting, at the place, and for the period shown opposite their names, but they presided at the subsequent meeting.

PRESIDENTS, TERMS OF SERVICE, AND PLACES OF MEETING.

1. William Clift	1870-1872	New York, N. Y.
2. William Clift	1872-1873	Albany, N. Y.
3. William Clift	1873-1874	New York, N. Y.
4. Robert B. Roosevelt	1874-1875	New York, N. Y.
5. Robert B. Roosevelt	1875-1876	New York, N. Y.
6. Robert B. Roosevelt	1876-1877*	New York, N. Y.
7. Robert B. Roosevelt	1877-1878	New York, N. Y.
8. Robert B. Roosevelt	1878-1879	New York, N. Y.
9. Robert B. Roosevelt	1879-1880	New York, N. Y.
10. Robert B. Roosevelt	1880-1881	New York, N. Y.
11. Robert B. Roosevelt	1881-1882	New York, N. Y.
12. George Shepard Page	1882-1883	New York, N. Y.
13. James Benkard	1883-1884	New York, N. Y.
14. Theodore Lyman	1884-1885	Washington, D. C.
15. Marshall McDonald	1885-1886	Washington, D. C.
16. W. M. Hudson	1886-1887	Chicago, Ill.
17. William L. May	1887-1888	Washington, D. C.
18. John H. Bissell	1888-1889	Detroit, Mich.
19. Eugene G. Blackford	1889-1890	Philadelphia, Pa.
20. Eugene G. Blackford	1890-1891	Put-in Bay, Ohio.
21. James A. Henshall	1891-1892	Washington, D. C.
22. Herschel Whitaker	1892-1893	New York, N. Y.
23. Henry C. Ford	1893-1894	Chicago, Ill.
24. William L. May	1894-1895	Philadelphia, Pa.
25. L. D. Huntington	1895-1896	New York, N. Y.
26. Herschel Whitaker	1896-1897	New York, N. Y.
27. William L. May	1897-1898	Detroit, Mich.
28. George F. Peabody	1898-1899	Omaha, Neb.
29. John W. Titcomb	1899-1900	Niagara Falls, N. Y.
30. F. B. Dickerson	1900-1901	Woods Hole, Mass.
31. E. E. Bryant	1901-1902	Milwaukee, Wis.
32. George M. Bowers	1902-1903	Put-in Bay, Ohio.
33. Frank N. Clark	1903-1904	Woods Hole, Mass.
34. Henry T. Root	1904-1905	Atlantic City, N. J.
35. C. D. Joslyn	1905-1906	White Sulphur Spgs., W. Va.
36. E. A. Birge	1906-1907	Grand Rapids, Mich.
37. Hugh M. Smith	1907-1908	Erie, Pa.
38. Tarleton H. Bean	1908-1909	Washington, D. C.
39. Seymour Bower	1909-1910	Toledo, Ohio.
40. William E. Meehan	1910-1911	New York, N. Y.
41. S. F. Fullerton	1911-1912	St. Louis, Mo.
42. Charles H. Townsend	1912-1913	Denver, Colo.
43. Henry B. Ward	1913-1914	Boston, Mass.

*A special meeting was held at the Centennial Grounds, Philadelphia, Pa., October 6 and 7, 1876.

CERTIFICATE OF INCORPORATION OF THE AMERICAN FISHERIES SOCIETY

We, the undersigned, persons of full age and citizenship of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with sections 599 to 603, inclusive, of the Code of Law for the District of Columbia enacted March 3, 1901, as amended by the Acts approved January 31 and June 30, 1902, hereby associate ourselves together as a society or body corporate and certify in writing:

1. That the name of the Society is the AMERICAN FISHERIES SOCIETY.

2. That the term for which it is organized is nine hundred and ninety-nine years.

3. That its particular business and objects are to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish; with power:

a. To acquire, hold and convey real estate and other property, and to establish general and special funds.

b. To hold meetings.

c. To publish and distribute documents.

d. To conduct lectures.

e. To conduct, endow, or assist investigation in any department of fishery and fish-culture science.

f. To acquire and maintain a library.

g. And, in general, to transact any business pertinent to a learned society.

4. That the affairs, funds and property of the corporation shall be in general charge of a council, consisting of the officers and the executive committee, the number of whose members for the first year shall be seventeen, all of whom shall be chosen from among the members of the Society.

Witness our hands and seals this 16th day of December, 1910.

SEYMOUR BOWER	(Seal)
THEODORE GILL	(Seal)
WILLIAM E. MEEHAN	(Seal)
THEODORE S. PALMER	(Seal)
BERTRAND H. ROBERTS	(Seal)
HUGH M. SMITH	(Seal)
RICHARD SYLVESTER	(Seal)

Recorded April 15, 1911.

CONTENTS

PART I

BUSINESS SESSIONS

Transactions of the American Fisheries Society

Forty-third Annual Meeting, held at Boston, Mass., Monday, Tuesday, Wednesday and Thursday, September 8, 9, 10 and 11, 1913.

Monday, September 8, 1913.

The meeting was called to order by the President, Dr. Charles H. Townsend, of New York City. The President then introduced Hon. Eugene N. Foss, Governor of Massachusetts, who made an address welcoming the Society to the State and expressed the wish that the meeting would prove to be both pleasant and profitable. President Townsend responded briefly, thanking Governor Foss on behalf of the members of the Society for his presence at the meeting and for his cordial greeting.

REGISTERED ATTENDANCE.

The President then ordered the roll-call of members to be taken. Sixty-seven members were registered for the meeting, as follows:*

Adams, Wm. C.
Babbitt, J. O.
Belding, David L.
Blain, James
Bower, Seymour
Buller, N. R.
Chambers, Fred W.
Corliss, C. G.
Crandall, A. J.
Dayries, J. A.
Dean, H. D.
DeRocher, J. D.
Dinsmore, A. H.
Dyche, L. L.
Embody, Geo. E.
Evans, Barton D.
Fearing, Daniel B.
Fearing, Mrs. Daniel B.
Field, George W.
Field, Irving A.
Foster, F. J.
Graham, A. R.
Graham, E. A.
Graham, Geo. H.
Hahn, E. E.
Hayford, Chas. O.
Herrick, Geo. H.
Hitchings, Frank E.
Hubbard, Waldo F.
Huntsman, O. G.
Hurlbut, H. F.
Johnson, R. S.
Kopplin, Philip
Locke, E. F.
Lydell, Dwight
May, Wm. L.
Merrill, Arthur
Merrill, M. E.

*Addresses will be found in the list of members at the back of this volume.

Miles, Geo. W.
Miller, Frank
Monroe, Otis
Morton, Wm. P.
Mowbray, Louis L.
Neal, Walter I.
Nesley, Chas. H.
Nichols, J. T.
Pope, T. E. B.
Porter, R.
Prince, E. E.
Race, Edward E.
Reighard, Jacob
Richards, G. H.
Rider, H. A.
Rogers, Jas. B.
Smith, H. C.
Starr, W. J.
Story, John A.
Thomas, Adrian
Titcomb, John W.
Townsend, Chas. H.
Viles, Blaine S.
Ward, Henry B.
Ward, J. Quincy
Willard, C. W.
Wilson, C. H.
Woods, John P.

MR. WILLARD, Rhode Island: Inasmuch as a number of gentlemen present have applications for membership on file, I suggest that their names be voted on at once in order that they may participate in this meeting.

PRESIDENT: The Treasurer will read the list of applications for membership.

The following list of 132 names was presented and voted upon:

NEW MEMBERS*

ADAMS, WM. C.
ALEXANDER, M. L.
ANDERSON, CARL A.
BALDWIN, MARCUS D.
BALL, FRANK H.
BELDING, DAVID L.
BELL, J. C.
BENNETT, CHAS.
BENSON, JOHN T.
BENTON, A. W.
BERG, GEORGE
BICKFORD, W. M.
BICKLEY, CHAS.
BLACKFORD, CHAS.
BLAIN, JAMES
BLAMEY, JOHN F.
CALLAWAY, FULLER E.
CASTING CLUB DE FRANCE
CHAMBERS, F. W.
CHAPMAN, L. DANA
CHURCHILL, WINSTON
COLES, RUSSELL J.
COOK, AUSTIN
CRANDALL, A. J.
CURRAN, WM. E.
DAVID, GEO. E.
DAVIS, H. C.
DAYRIES, J. A.
DENISON, A. P.
DE ROCHER, JAS. D.
DICKINSON, F. H.
DICKINSON, P. A.
DODGE, LESLIE G.
DOWNEY, BEN
DREW, S. S.
DURKIN, D. L.
EMBODY, GEO. C.
ESTES, B. E.
FLYFISHERS CLUB
GARDNER, JOHN W.
GERRY, PETER G.
GERRY, ROBERT L.
GETZ, NORMAN
GOFFIN, ROBERT A.
GOODSPEED, I. B.
GOODWIN, O. C.
GOURVILLE, J. H.
GRAHAM, E. A.
GUERIN, THEOPHILE
GUPTIL, GEO. I.

*For addresses see list of members at back of volume.

HALTER, LAWRENCE
HARRIMAN, AVERIL
HAYFORD, ROBERT E.
HEIMAN, A. J.
HERRICK, GEO. H.
HIGGINS, ALF. S.
HITCHINGS, FRANK E.
HOFFSES, ELVIN J.
HOFFSES, G. RAYMOND
HOVER, HERBERT
HOWARD, ARTHUR D.
HOWES, ELIJAH S.
HUNTSMAN, A. G.
INGALLS, GEO. M.
JONES, E. LESTER
JOHNSON, E. H.
JOHNSON, HENRY J.
JOHNSTON, CASSIUS A.
KINNEY, M. J.
KNIGHT, H. J.
LEE, HARVEY S.
LOWELL, CARLETON W.
MACCALLUM, G. A.
MCINTYRE, DOUGLAS N.
MCLAIN, W. S.
MARIS, JAS. D.
MATHEWSON, E. P.
MERRILL, ARTHUR
MERSHON, W. B.
MIXTER, SAM'L J.
MONROE, OTIS D.
MONROE, WM.
MOORE, ALFRED
MURPHY, C. H.
NEAL, WALTER I.
NEWPORT FREE LIBRARY,
NEWPORT HISTORICAL SOCIETY,
OAKES, WM. H.
OFTHSUN, T. O.
O'HARA, JOSEPH
PAGE, W. H.
PATTERSON, A. G.
POOLE, GARDNER
PURDUM, JAS. K. P.
REDWOOD LIBRARY,
REIDEL, F. K.
REYNOLDS, JAS. A.
RHINES, WALLACE D.
ROBIRDS, GEO. L.
ROACH, EDWIN R.
ROSE, W. G.
RUSSELL, J. R.
RYAN, CALVIN D.
SACHS, JAS. G.
SANTA BARBARA PUBLIC LIBRARY,
SCHLEICHER, R. O.
SCHWARTZ, BENJAMIN
SEAGRAVE, ARNOLD
SHELFORD, VICTOR E.
SHERWIN, GERALD
SINGLETON, J. ERNEST
SMITH, HERBERT C.
STAPLETON, J. J.
SULLIVAN, WALTER E.
THAW, AUGUST B.
THOMAS, ADRIAN
TICHENOR, A. K.
TIMSON, WM.
TREXLER, COL. HARRY C.
TRIGGS, CHAS. W.
TURNER, CHAS. C.
TUXBURY, CHAS.
TYSON, JAS. W.
VARDEN, GEO. S.
WATTS, A. E.
WEIL, WALTER G.
WELSH, WM. W.
WESTERFELD, CARL
WESTERMANN, J. H.
WINTER, J. H.
WISNER, J. NELSON
WOODS, JOHN P.

PRESIDENT: It is most gratifying to have such a number of applications for membership. Nothing like it has ever been known in the history of the Society.

The President has to report that the annual volume of Transactions is probably on the way from the press. In the absence of the Recording Secretary, Mr. Ward T. Bower, in Alaska, the work of getting out this volume was turned over to his associate in the United States Bureau of Fisheries, Mr. H. D. Aller, who finally became dismayed at the task of editing the large mass of manuscript and requested help of me. Papers sent to mem-

bers for correction were not always returned promptly, so the volume was very much delayed. It seemed advisable to do some editing and to blue-pencil some of the irrelevant matter in the discussions. This was done with the approval of members of the Executive Committee.

We have been publishing our report rather carelessly, giving the discussions *in toto*, which probably is not wise, and a good deal of matter could be left out if this were placed in the hands of a careful editorial committee. Besides, the society is not prosperous enough to do so much printing, and it is necessary for us to condense a little where it can be done without harm to our volume. I hope that a little later on in the meeting we will be able to decide upon the best course to pursue in this matter.

It seems desirable, also, that we should consider later at this meeting the matter of compensating the Secretary, because the labor is too great for any one man to undertake for nothing, and besides, the Secretary is subject to criticism when he attempts to edit papers and there are always some papers which have meat in them but which are too voluminous and which really need editing.

REPORT OF THE RECORDING SECRETARY.*

To the Officers and Members of the American Fisheries Society:

The chief duties of this office have had to do with the preparation of the report of the Denver meeting and publishing same in the annual volume comprising the Society's Transactions. The usual correspondence incident to the Society's activities has been given proper attention. No Assistant Secretary was elected at the last meeting, the selection of this office being left to the Secretary. Accordingly Mr. Henry D. Aller, of the Bureau of Fisheries, Washington, D. C., was named to fill this office. The Society was fortunate in Mr. Aller's acceptance of this position, as in March it became necessary for the Secretary to proceed to Alaska for a protracted period, and most of the concluding work of getting out the Transactions devolved upon the Assistant Secretary. As there may be a repetition of extended absence from headquarters at Washington, your Secretary feels that under the circumstances he cannot longer serve the Society usefully in any capacity as an active officer.

*Owing to the absence of the Secretary in Alaska, this report was not presented at the meeting, but is inserted here for the information of the members of the Society. *Editor.*

Prior to the Secretary's departure, most of the material for the report was made ready for the printer. In this connection, it seems appropriate to state that discussions, particularly in the business section of the Transactions, are condensed and epitomized much more than has been the custom during recent years. In view of the deficit in the Treasury, this course was adopted for the purpose of saving as much as possible on the cost of getting out the Transactions. Also for this reason less expensive paper, though of substantial quality, was selected. The contract was again let to the W. F. Roberts Company, of Washington, D. C.

During the year reports have been sold in the sum of $34.07. As ordered by the Society at the 1911 meeting, the charge has been $1.00 per volume, except the Fortieth Anniversary issue (1910) for which the rate has been $2.00 per copy. It is unfortunate that a number of requests for various issues could not be supplied owing to the scarcity of copies other than for some six years back. Reports in the hands of the Secretary are as follows:

1895	1	1904	62
1896	1	1905	1
1897	1	1906	93
1898	1	1907	86
1899	1	1908	118
1900	3	1909	136
1901	1	1910	114
1902	4	1911	128
1903	0	1912	230

The raising of funds wherewith to liquidate the deficit of about $500 at the beginning of the year has been an important feature since the last meeting. Circulars have been sent out during the year, asking for donations; also asking that life membership be taken out. As a result of these appeals donations were received by the Treasurer in the sum of $197.75 and twelve life memberships at $25 each were paid for, thus bringing in a sum of nearly $500. The origin of the indebtedness dates back to the unusual expenditure of approximately $1,500 for publishing the Fortieth Anniversary number issued in 1910, a volume of 469 pages.

During the year the following members have resigned:

Paul North ('02), Cleveland, Ohio.
Ethel M. Smith (Miss) ('10), Washington, D. C.
Oregon Milton Dennis ('04), Baltimore, Maryland.
Dr. Oliver L. Jones ('95), New York, N. Y.
Prof. James L. Kellogg ('98), Williamstown, Massachusetts.
C. A. Reed ('03), Santa Cruz, California.
Dr. H. C. Bumpus ('98), Madison, Wisconsin.
Nelson Bailey ('04), Wells River, Vermont.
Dr. D. W. Green ('02), Dayton, Ohio.
Henry Russell, ('97), Detroit, Michigan.

Since the last meeing the demise of the following members has been reported:

Livingston Stone, Swissvale, Pa. Charter member. Died December 24, 1912.
S. L. French, ('11), Dallas, Texas. Died November 8, 1912.
H. G. Saunders ('02), Chattanooga, Tenn.
Chester K. Green ('04), U. S. Bureau of Fisheries, Cape Vincent, N. Y. Died, November 5, 1913.
John W. Fredrum ('11), Denver, Colo. Died January 9, 1913.
H. D. Goodwin ('08), Milwaukee, Wis.

During the year accessions to the rolls of active membership have numbered 132. The active membership is now 613; total membership 706.

In bringing to a close his tenure of office, your Secretary desires to express his sincere appreciation of the honor which has been accorded him for the opportunity of serving an organization of the character and high standard of the American Fisheries Society.

Respectfully submitted,

WARD T. BOWER,
Recording Secretary.

JUNEAU, ALASKA, September, 1913.

REPORT OF THE TREASURER.

To the American Fisheries Society:

I herewith submit my annual report as Treasurer from September 3, 1912, to Sepember 8, 1913.

RECEIPTS

1912-13

Sale of reports	$ 34.07	
Yearly dues	999.00	
Life membership fees	300.00	
Donations from members	197.75	
		$1,530.82

EXPENDITURES

1912				
Sept.	5.	Balance due Treasurer	$7.99	
"	5.	G. H. Graham, printing, etc., Denver	6.85	
"	16.	C. J. Butler, P. M. envelopes	10.68	
"	24.	W. F. Roberts Co., Reports and mailing	949.60	
Oct.	11.	Clerical services	3.50	
"	11.	C. J. Butler, P. M. envelopes	10.68	
1913				
Jan.	28.	J. H. Rush, lettering certificates	27.20	
Feb.	1.	Registry and postage, Receipt books	.38	
"	6.	J. H. Rush, lettering certificates	2.40	
"	6	McDermott & Goodwin, stenography	182.00	
Mar.	29.	Ward T. Bower, Sec., postage, etc.	19.95	
June	4.	C. J. Butler, Postmaster, envelopes	10.68	
Aug.	4.	J. H. Murphy, printing	1.50	
"	7.	Irving Press, New York, printing	11.15	
Sept.	4.	Irving Press, New York, printing	25.00	
"	4.	Dr. C. H. Townsend, Pres., postage, etc.	19.72	
				$1,289.28
Sept.	8.	Balance cash on hand		241.54
				$1,530.82

Respectfully submitted,

C. W. WILLARD, *Treasurer.*

Westerly, R. I., Sept. 8, 1913.

This report was accepted and referred to the Auditing Committee.

For the information of the members, the Treasurer made the following explanations of the financial status of the Society:

"I will state, gentlemen, that while it may appear by this that we are out of debt, and have cash on hand to the extent of $241.54, it is not so. The $949 which appears to have been paid for the reports and other expenses here, with the exception of a few items have been for the meeting of 1911 instead of the meeting held a year ago. We are in debt at the present time for the publication of the Annual Report for 1912, which is now being mailed to the members.

"During the past year a printed letter calling on members for donations in the sum of one dollar and upwards, to wipe out the indebtedness of the Society, has been circulated with the result that $257.75 have been donated for this purpose. The list of donors follows:*

Contributing $1.00,—August J. Anderson, J. F. Anderson, James Annin, Howard S. Bailey, W. O. Buck, Wm. A. G. Buller, C. H. Bushman, R. E. Coker, Thos. M. Darrah, H. D. Dinsmore, Kelley Evans, I. A. Field, Chas. W. Green, E. E. Hahn, W. K. Hancock, G. Hanson, J. R. Hayes, Chas. O. Hayford, E. D. Hemmingway, W. P. Herrick, T. D. Hobart, Glen C. Leach, Chas. E. Lewis, Geo. N. Mannfeld, J. P. Marks, R. R. Meentz, G. J. T. Meyer, Geo. T. Mills, M. G. Munly, H. Wheeler Perce, T. E. B. Pope, E. E. Race, Lewis Radcliffe, H. D. Reed, Waldo Schmidt, Wm. P. Seal, Marion G. Sellers, Frank A. Shebley, John A. Story, W. H. Thomas, W. P. Thomson, Jas. N. Tierney, C. H. Walters, Edward C. Whitman, Grant E. Winchester, S. G. Worth, and E. P. Yerrington.

Contributing $2.00,—Geo. L. Alexander, E. M. Ball, Jas. T. Barron, J. H. Bissell, F. H. Britton, C. G. Corliss, C. K. Cranston, S. W. Downing, Barton D. Evans, C. F. Fowler, Philip Hartman, W. F. Hubbard, Chas. Lay, Lewis H. Smith, A. T. Vogelsang and Bryant Walker.

Contributing $5.00,—John P. Babcock, S. Thurston Ballard, S. P. Bartlett, E. A. Birge, Wm. H. Boardman, Edwin C. Kent, Robert T. Morris, J. F. Moser, Henry C. Smith, Hugh M. Smith and C. C. Wood.

Contributing other amounts,—$25.00, N. R. Buller; $15.00, Chas. H. Townsend; $10.00, Kenneth Fowler, North Alaska Salmon Co., by J. P. Haller, R. Tyson White and John P. Woods; $8.00, N. B. Church; $6.00, W. J. Hunsaker; $4.00, H. F. Moore; $3.00, Seymour Bower, P. J. Engelbrecht, W. E. Meehan, Henry T. Root, J. W. Titcomb, Henry B. Ward, and W. P. Wires; $2.50, North Alaska Salmon Co.; $1.25, George Morcher.

PRESIDENT: I feel that the American Fisheries Society will be able to take care of itself. It will probably cease

* This list is corrected to March 1, 1914.—*Editor.*

to distribute its rather expensive volume to members who are in arrears, and the volume can be edited in a manner which will make it less expensive.

I have to announce the arrival of the Mayor. Gentlemen, we have with us this morning another distinguished visitor, Hon. J. F. Fitzgerald, Mayor of Boston, who wishes to extend a word of welcome.

Mayor Fitzgerald gave the Society a cordial welcome to the city and made some interesting remarks on the increase in price of fishery products in Boston since his boyhood. The suggestion was made that ocean liners equipped with wireless telegraph apparatus might be encouraged to aid the work of the fishermen by reporting the location of schools of mackerel they chance to pass through. The Mayor further recounted some of his experiences while a member of Congress in the attempt to secure the passage of legislation for the protection of the lobster, and stated that the best means of securing the passage of any measure consists of personal solicitation of members of Congress while supplying them at the same time with definite information as to the value of such legislation.

President Townsend presented the thanks of the Society to Mayor Fitzgerald for his address. Mr. Daniel B. Fearing was then called upon to give the report of the Executive Committee.

REPORT OF THE EXECUTIVE COMMITTEE.

MR. FEARING: During the year, at the approval of the Executive Committee, as Chairman, I sent out a request for funds from the Society to aid the Treasurer. I sent at my own personal expense more than six hundred communications, enclosing a stamped envelope addressed to Ward T. Bower, Secretary, and a printed postal card, which only had to be filled in and sent. To these communications that I sent out, there were eighteen members that were good enough to answer; but, out of the eighteen members that answered, I got eight life member-

ships, and seventeen or eighteen annual members, with a donation of ten dollars from one man and a dollar from another.

The Executive Commitee have had two short meetings and before the end of this meeting will suggest certain measures which they think the society ought to act upon in regard to the distribution of the transactions and in regard to the revision of the membership, which may be brought before the Committee on Resolutions later.

The Society then adjourned for the morning.

The afternoon was spent in visiting the Aquarium in South Boston, following which a tour was made through the parks of the city at the invitation of the Boston Park Commission.

The evening session was called to order at 8 o'clock and the President announced the following committees:

Nominations: George W. Field, N. R. Buller, J. W. Titcomb, J. Q. Ward, W. L. May.

Place of Meeting: J. P. Woods, C. W. Willard, W. C. Adams.

Auditing: G. W. Miles, Seymour Bower, Dwight Lydell.

Program: H. D. Dean, F. Miller, C. G. Corliss.

Publication: R. C. Osburn, Bashford Dean, J. T. Nichols, T. H. Bean.

Publicity: H. W. Perce, G. H. Graham, T. S. Palmer, G. E. Jennings.

Resolutions: Jacob Reighard, E. E. Prince, L. L. Dyche.

PRESIDENT: It has been difficult to get the annual volume edited this year, and I think we cannot do better than to get this Publication Committee all located near together and for that reason I have appointed members living in or near New York City.

PRESIDENT: I have a letter from the United States Commissioner of Fisheries, Dr. Hugh M. Smith, who sends a paper to be read and also his best wishes for a successful meeting. Will Dr. George W. Field kindly

read Dr. Smith's paper, which is entitled, "The Need for a National Institution for the Technical Instruction of Fisherfolk."

Following the reading of this paper Dr. Field moved the appointment of a committee to aid in furthering any action looking toward the consummation of this matter. Adopted.

The President later appointed Prof. Jacob Reighard, Prof. E. E. Prince and Prof. Bashford Dean to this committee.

Tuesday, September 9, 1913.

The entire morning session was occupied with the reading and discussion of two papers. E. E. Prince,—"A Perfect Fish Pass: Some suggestions as to the Defects in Fish Passes and How to Overcome Them." L. L. Dyche,—"Possibilities of an Acre Fish Pond."

Owing to the number of papers on the program it was voted to abandon the excursion which had been planned for the afternoon in order to devote the time to the reading and discussion of papers.

Adjourned.

At the afternoon session the time was devoted entirely to the program, which was taken up in the following order:

C. H. Townsend,—"The Private Fish Pond—A Neglected Resource."

L. L. Dyche,—"One Year's Work at the Kansas State Fish Hatchery."

J. P. Snyder,—"Notes on Striped Bass" (read by H. D. Dean).

Jacob Reighard,—"Improvements of Fishing Through a Knowledge of the Breeding Habits of Fishes."

At 8 o'clock in the evening the Society again convened for the reading and discussion of the following papers:

N. R. Buller,—"The Work of the Pennsylvania Fisheries Department."

D. L. Belding,—"Conditions Influencing the Growth of Clams (*Mya arenaria*)."

Wednesday, September 10, 1913.

PRESIDENT: I have received a letter from the United States Commissioner of Fisheries containing the offer of a fund of $250 for the use of this Society. If the members of the Society will please do a little thinking about this matter, I will bring it up again for discussion this afternoon, for it is very important.

We have letters from old members who have been in the Society for many years. Chas. G. Atkins, of Maine, sends his paper and regrets that he will not be able to attend the meeting. Our very dear friend, Professor Forbes, head of the State Laboratory of Natural History in Illinois, also regrets that he is unable to be with us.

Another letter from the Gloucester Master Mariners' Association on behalf of the Master Mariners, reads as follows: "I tender to you the use of our rooms in Gloucester. There is plenty of room to hold meetings." It is signed by Mr. Stapleton, Secretary. The Society will probably not have time to go down as a body.

A letter from the Alaska Packers' Association in San Francisco, suggests that we might invite the larger fishery associations of the country to become life members of this Society, and that they are willing to subscribe now. We need more members and a larger income than we get from our two dollar dues, and, if the members of the Society will make it their business to speak to some of the managers of fishery firms, it is quite likely that we can get some very desirable members and considerable in the way of funds.

This Society is indebted to Mr. Daniel B. Fearing for a magnificent index to the publications of the American Fisheries Society, covering the first forty volumes of the annual Transactions. This has been prepared very carefully by Mrs. C. C. Gardner of Newport, under Mr.

Fearing's direction and has been under way for two or three years. Will Mr. Fearing please explain.

MR. FEARING: The work is all done with the exception of a few corrections and verifications and will then be ready for the printer. It is an index in the simplest form, going alphabetically through all the volumes. If one desires to look up any fish, he can easily find where it is discussed. For instance on the subject of fish-ways there are twenty or thirty articles; trouble in regard to fish-ways established by the United States Government; discussion on fish-ways; Grand Lake Stream fish-ways, etc.

This will be ready for the printer after a few days work in verifying certain entries and having it re-typed after the corrections are made. I will then send it to the President or Secretary in the hope that some time the Society may be able to publish it. (Applause).

Prof. Reighard, as Chairman of the Committee on Resolutions, moved a vote of thanks to Mr. Fearing and Mrs. Gardner for the invaluable service rendered to the Society and to all persons interested in fish and fisheries by the preparation of the index.

The resolution was adopted.

President Townsend commented on the great value of such indexes and expressed the hope that the Society would soon be able to publish it.

The following papers were then read and discussed:

I. A. Field:—"The Development of the Salt Water Mussel Industry."

J. Reighard:—"A Plea for the Preservation of Records Concerning Fish."

E. E. Prince:—"Some Animals and Conditions Inimical to Fish Eggs and Larvae in the Sea."

G. W. Field:—"The Alewife Fishery of Massachusetts."

Col. Joseph H. Acklen was called on to address the Society and responded briefly.

PROF. WARD, of Illinois: Before we adjourn, I wish to call to the attention of members of the Society a matter

concerning which I have not consulted our worthy President. I feel it is necessary to make this statement in advance.

Last year the Society expressed itself very positively regarding the matter of the Alaska Fur Seal Fisheries and the part which the Bureau of Fisheries and the Department of Commerce and Labor should have in the decision of that question.

Some of you remember that, in the course of the winter, Dr. Townsend, our President, was called to testify at Washington. The testimony which he gave as a scientific expert did not suit certain political gentlemen, and they proceeded to impugn his testimony not on scientific grounds, but by charging him with various forms of dishonesty, and so forth and so on. For a short period Dr. Townsend enjoyed newspaper notoriety that seldom falls to a scientific man. Those personally acquainted with him were sure that there was something not explained in the paper, but I think it very likely that there were other persons in the country, who did not have such knowledge of his character and standing as a scientific man, and I do know that some persons were astonished and perhaps grieved at the appearance of duplicity in his conduct shown, or apparently shown, by this testimony. The New York Zoological Society took the matter seriously, investigated it very carefully, and, in a document, called attention to certain facts. The charges that were made were contained in the report of the majority of a Committee of the House of Representatives; the report was given a wide circulation before it was acted upon by the full committee. The rest of the committee presented a minority report in direct opposition to that of the majority.

The only references to Dr. Townsend were simply distortions made for political purposes in connection with the discussion before Congress.

After a most careful investigation the New York Zoological Society adopted unanimously the report of the

minority, which states in very explicit terms that *none* of these charges were true.

It seems to me particularly appropriate to bring the matter before this body at this time: to furnish, in the first place, a specific statement to you that the charges have been investigated and declared groundless; and, secondly, would it not be proper that this Society should express distinctly its confidence not only in the scientific standing but also the integrity of our President?

I should like to move that the Society, at this time, desires to express its fullest confidence in President Townsend, and its regret that the press should have been called upon to circulate such distorted statements regarding the facts in this case.

MR. BOWER, of Michigan: I will take the liberty of putting the question before the Society, inasmuch as the President would hardly wish, perhaps, to bring this up. I would like to say we have acted together in this matter. Our President has been unjustly attacked, simply because certain selfish interests could not control him; he has been assailed because he represented fearlessly the position of the U. S. Bureau of Fisheries, and I hope that this Society, by a unanimous vote, will show its appreciation of their confidence in him. Those that favor this motion will signify it by rising.

Carried unanimously.

DR. TOWNSEND: I have nothing further to say on the fur seal matter, except that I have been in this unfortunate fight for twenty-five years, and I am still in it. Our report, which has just come out, contains my remarks of last year, and I have made similar remarks which have been printed elsewhere. I am still putting myself on record regarding what is going to happen on the Fur Seal Islands. This move of the House Committee was really not against me but was an attempt to discredit the Government control of the Islands, so that the Islands could be leased to private parties. The next

move of the seal lobby will be to introduce a bill to provide for the leasing of the fur seal fishery.

Adjourned.

The Wednesday afternoon session was devoted entirely to business, and the following papers remaining on the program were, by vote of the Society, read by title and referred to the Publication Committee:

A. S. Bickford,—"Notes on the Montana Grayling."

Wm. P. Seal,—"Suggestions of Possible Interest to the American Fisheries Society and to Fish Commissions."

F. F. Dimick, "The Fish Trade Organizations."

Phil. C. Zalsman, "Experiments in Fish Culture While in the Employment of the Michigan and Wisconsin Fish Commissions."

Charles H. Nesley, "Small Mouth Black Bass."

J. T. Nichols, "Concerning Young Bluefish."

Charles G. Atkins, "The Atlantic Salmon."

W. E. Meehan, "The Establishment of an Aqarium in Philadelphia."

Henry C. Rowe, "Oysters; A Desirable Food."

PRESIDENT: No action has yet been taken on the letter from the United States Commissioner of Fisheries relative to his fund of $250 to be administered by the Society.

Without discussion it was moved and carried that the matter be referred to the Executive Commitee.

PRESIDENT: The Chair has to suggest the desirability of revising our list of honorary members. The Society is not rich enough to give away fifty volumes a year to the governors of the states, which may go into official waste-baskets. The active members not in arrears are entitled to them.

MR. FEARING, of Rhode Island: Might I suggest that the distribution of the annual reports be left to the discretion of the Secretary and Treasurer? There are no specific instructions in the By-laws that every member of the Society shall receive the Transactions. If we

remove the Governors of the States and the President of the Nation from the list that will relieve us of 49 copies, which is quite a saving.

PROF. WARD, of Illinois: This is a rather heavy burden to throw upon our Secretary and Treasurer and I think that the two, while practically doing the work, should be shielded behind the Executive Committee.

After considerable further discussion, Professor Ward presented the following motion which was seconded by Mr. Fearing:

Moved that the Secretary and Treasurer dispose of the annual Transactions with the approval of the Executive Committee. Motion carried.

AMENDMENTS TO THE CONSTITUTION.

PROF. WARD: Two subjects have been under discussion in special meetings of the Society and I was requested to draft the present amendments covering these items. As the constitution now stands, no library nor club can subscribe for the Transactions, and yet I am sure you will all agree that we are anxious to sell as many as possible. We propose to amend Article II by adding the following:

Any library, sporting or fishing club, society, firm or corporation may upon two-thirds vote and the payment of the regular annual fee become a member of this Society and entitled to all its publications.

Moved and carried that this clause be added to the Constitution.

PROF. WARD: The second item should be the paragraph following the one just adopted. Add to the Constitution these words:

Any person, society, club, firm or corporation, on approval by the Executive Committee and on payment of $50.00 may become a patron of this Society with all the privileges of a life member and then shall be listed as such in all published lists of the Society. The money thus received shall become a part of the perma-

nent funds of the Society and the interest alone be used as the Society shall designate.

You will recall that we have been offered a nucleus of $250.00 for a permanent fund and this furnishes a way in which this permanent fund can be slowly advanced to a point where it can be a great benefit and credit to the Society.

This second amendment was also adopted by the Society as a part of the Constitution.

Mr. Nesley inquired whether any back volumes of the Transactions could be secured. The President informed him that they could be purchased from the Secretary.

Mr. Miles made the report for the Auditing Committee.

REPORT OF AUDITING COMMITTEE.

In the absence of the Secretary and of any records, the Auditing Committee has not been able to make up a list of the membership and the number who have paid dues; but the Committee has checked the vouchers for expenditures with the report made by the Treasurer and finds it correct.

Respectfully submitted,

GEO. W. MILES,
S. BOWER,
DWIGHT LYDELL,
Auditing Committee.

This report was adopted.

REPORT OF COMMITTEE ON RESOLUTIONS.

PROF. REIGHARD: The Committee on Resolutions has a number of Resolutions to present. It has interpreted its powers as being confined to the presentation to the Society of those resolutions concerning its relations to things outside of the Society, and has not undertaken to present resolutions referring to its internal affairs. Those should come from the Executive Committee or

other members on the floor. The first one is an appreciation of courtesy:

I. RESOLVED: That the American Fisheries Society hereby expresses its appreciation of the many courtesies extended to it by the Governor and Council of the Commonwealth of Massachusetts, by the Mayor and Park Commission of the City of Boston, by the Massachusetts Fish and Game Commission and by the various organizations of Boston fish dealers. It desires to thank them individually and collectively for their part in a most successful meeting and directs that copies of this resolution be transmitted to them.

Resolution adopted.

II. *Whereas* the fisheries of this nation are an asset so essential to the well-being of the people and the national fishery resources are amenable to intelligent conservation and wise exploitation just as are our agricultural resources;

BE IT RESOLVED that the American Fisheries Society expresses its great satisfaction at the appointment of Dr. Hugh M. Smith to the National Commissionership, assuring him and his associates in the Bureau of Fisheries, Washington, D. C. of loyal support in every effort to maintain and develop the marine and fresh-water fisheries.

Resolution adopted by rising vote.

III. *Whereas* with the vast increase in the population and the consequent growing demand for greater food supplies, the cost of living has so augmented as to attract serious and wide-spread public attention;

BE IT RESOLVED that the American Fisheries Society urges private individuals, civic and other corporations, and the various Fish Commissions to study and to develop the resources of public and private lakes, ponds and streams and to more fully utilize them for the rearing of food fishes.

Resolution adopted.

IV. *Whereas* Congress enacted legislation relative to migratory birds;

BE IT RESOLVED that this Society favors legislation in regard to fishes which migrate between States, the importance to the people of the conservation of fishery resources being not inferior to that of the preservation of migratory birds, neither of which should be impaired for private gain to the disadvantage of the people. The Society, therefore, endorses the following bills now pending in the United States Congress: H. R. 7774 and H. R. 7775.

V. *Whereas*: The fisheries of certain States and Provinces are being immensely depleted by unwise local regulations and whereas the whitefish fishery, among others is of special importance in the question of the food fish supply of this continent,

BE IT RESOLVED, that this Society urge upon every citizen and every State and Province, the increasing importance of adequate protection of this valuable food fish product and the development of whitefish fisheries under wise and competent Dominion, National and State direction and authority. And be it further

RESOLVED: That this Society recommends and gives its endorsement to that part of the International Agreement on the Great Lakes

regarding size limits of the common whitefish, to wit, a minimum size limit of two pounds in the round, and urge that in the formulation of regulations regarding the protection of this species, this standard method of weight only shall be used.

MR. C. H. WILSON, of New York: I want to speak regarding New York State. Ninety-five per cent of the fish we use in New York State comes from states bordering on the Great Lakes and Canada. Up to seven years ago we did not have a protective law regarding whitefish in the Great Lakes. In enacting legislation in harmony with the treaty the two-pounds-in-the-round law was passed, but without being operative owing to the non-action of the State Commissioner. The two-pound law was thrown out and the 12-inch law passed in its stead. We traveled under this 12-inch whitefish law for one year, when the Chairman of the Conservation Commission of New York State appeared before the Senate Committee and stated to them that we had been a dumping ground of immature and illegally taken whitefish all over the State. In Manitoba there were several carloads of immature whitefish ready when New York passed the 12-inch law. These were shipped in and I bought whitefish eight and nine inches long, taken out of Manitoba lakes in 1910-11, that, when thawed out, fell apart.

I have been in this fight on the whitefish question for seven years and I ask you to give us your endorsement of this two-pound limit. There is another resolution dealing with the whitefish and if we may have it read I will not ask for more time now.

PRESIDENT: The Committee on Resolutions informs me that these two resolutions can be considered together. Is the Society prepared to hear the second resolution?

PROF. REIGHARD: The second resolution provides for the appointment of a committee to determine the length and weight of all whitefish; the idea being that it is easier to measure fish than to weigh them, and if the length of the two-pound fish is known, it will be easier to enforce the law.

VI. BE IT RESOLVED: That the president of this Society shall appoint a committee of five, composed of members from Canada and

the United States actively engaged in whitefish fishery operations and others familiar with the life and habits of the fish. Said committee to determine the relative sizes of the same as shown in a measure of length and a measure of weight. Such committee to report at the next annual meeting of the Society.

The Committee on Resolutions has voted to submit both of these resolutions. If it is the opinion of the Chair, they may be considered together to save time.

PRESIDENT: What is the pleasure of the Society?

MR. WILSON: This law has been violated repeatedly. I have bought the fish myself. In regard to this second resolution, the question of knowing just how much a two-pound fish will measure is an absolute necessity. My State changed the regular method of measurement by pounds to a measurement by inches with results which I have tried to explain. Mr. S. W. Downing of the Put-in Bay hatchery had under observation 6,500 whitefish. He sorted out 200 of the smallest fish, and not one fish of this 200 sustained the contentions of the New York State Commission as voiced by parties interested.

PRESIDENT: Is the Society prepared to deal with these resolutions? If they are adopted the Chair is willing to appoint the committee recommended by the second resolution.

Moved and carried that both resolutions be adopted.

PROF. REIGHARD: May I make one suggestion in regard to this second resolution? The members of this committee should adopt a uniform method of measuring whitefish. The method of measuring is from the end of the snout along the side to the base of the tail fin, but the tail fin is sometimes included.

PRESIDENT: The Chair appoints as members of this committee: Messrs. S. W. Downing, J. Reighard, E. E. Prince, A. G. Huntsman and S. Bower, who will please report in regard to this matter at the next meeting.

MR. FEARING: I have to offer two resolutions relating to the affairs of the Society.

I. RESOLVED: That the Secretary be instructed not to send copies of the Annual Transactions to members in arrears for dues.

Resolution adopted.

II. RESOLVED: That the Recording Secretary be given annually $50.00 in addition to necessary expenses of the office.

I would like to speak a word in favor of this. It has been the custom of the Society up to the present time to return the Recording Secretary nothing for his labor. His work has been purely a labor of love and is more than the Society ought to ask a man to give.

MR. SEYMOUR BOWER: As I understand it, the publication of the Proceedings is now referred to the Publication Committee. That will take 75 per cent of the duties which formerly devolved upon the Secretary. That should be taken into consideration.

PRESIDENT: The Chair understands this Publication Committee to be a reference committee to which the Secretary can appeal. The Chair has therefore appointed members living in New York State, with whom the Secretary can confer on matters of fish culture and regarding the quality of papers submitted. The Secretary has still practically the same amount of work as before.

Motion put and resolution adopted.

PRESIDENT: The Secretary and the Publication Committee should have power in the matter of editing papers. Very often papers are sent in which have meat in them, but which are not in condition to send to the printer. They need blue-penciling and some times scientific correction.

A motion is in order to give the Recording Secretary and his advisory Publication Committee power to deal with papers submitted for publication by the Society.

MR. WILSON: As one who has enjoyed having his paper fixed up in a very nice manner, I would like to make such a motion.

PROF. WARD: I desire to second the motion, and, in so doing, would ask you whether it is meant that power should be given to prune or to reject entirely such papers as they see fit, having in mind the income of the Society and the possible size of the volume.

PRESIDENT: The Chair used the words "with power" in that sense. Regarding the 1912 Transactions, in the

absence of the Secretary the Chair rejected entirely one paper that was submitted without signature and another that was merely a State list of fishes, but was manifestly incomplete and without annotations. Perhaps the Acting Recording Secretary and the Chair assumed too much authority, but that is what happened.

MR. BOWER: Authority should be given to cut down discussion.

PRESIDENT: The phrase "with power" includes that.

MR. LYDELL: They would have power to cut out entirely any papers submitted for publication?

PRESIDENT: That would be power to use their best judgment to make the publication of the Society as creditable as possible. The motion before the house is:

That the Recording Secretary and Publication Committee be given full power to deal with papers submitted for publication by the Society.

Adopted by the Society.

PRESIDENT: I am glad the Society has taken this action, because this work has thrown a weight of responsibility on the Recording Secretary which he was loth to accept. Hitherto he has had to use his own discretion or crowd in what was not always acceptable, as the Executive Committee were not generally accessible.

Will the Committee on Time and Place of Meeting please report.

TIME AND PLACE OF MEETING.

MR. WOODS, of Missouri: Mr. Chairman, the names of cities presented for the consideration of your committee were Chicago, Detroit, New Orleans and Indianapolis. The committee has unanimously selected New Orleans, and has decided upon September 30 and October 1, 2 and 3, 1914, as the proper time for holding the meeting.

Moved and carried that the report of the Committee be adopted.

MR. DAYRIES, of New Orleans: I wish to thank the Society most cordially for having selected New Orleans for the next meeting place, and to say that it will be

our utmost endeavor to make your stay with us enjoyable and interesting.

PRESIDENT: We will now proceed to the election of officers for the coming year. The report of the Committee on Nominations will be presented.

REPORT OF COMMITTEE ON NOMINATIONS.

MR. CORLISS: If you will refer to the program, you will see that the principle of selection has been one of promotion. The Committee submit the following:

President: Henry B. Ward, Urbana, Ill.

Vice-President: Daniel B. Fearing, Newport, R. I.

Corresponding Secretary: George W. Field, Sharon, Mass.

Recording Secretary: Raymond C. Osburn, New York Aquarium, New York.

Treasurer: Charles W. Willard, Westerly, R. I.

VICE-PRESIDENTS OF DIVISIONS.

Fish Culture: Dwight Lydell, Comstock Park, Michigan.

Aquatic Biology and Physics: L. L. Dyche, Pratt, Kansas.

Commercial Fishing: Kenneth Fowler, 1 Fulton Fish Market, New York City.

Angling: H. Wheeler Perce, Chicago, Ill.

Protection and Legislation: T. S. Palmer, Washington, D. C.

EXECUTIVE COMMITTEE.

Jacob Reighard, Chairman, Ann Arbor, Michigan; George H. Graham, Springfield, Mass.; N. R. Buller, Harrisburg, Pa.; J. Quincy Ward, Frankfort, Ky.; George W. Miles, Indianapolis, Indiana; Ernest Schaeffle, San Francisco, California; J. A. Dayries, New Orleans, Louisiana.

COMMITTEE ON FOREIGN RELATIONS.

George Shiras, 3d, Washington, D. C.; E. E. Prince, Ottawa, Canada; H. M. Smith, Washington, D. C.;

Overton W. Price, Washington, D. C.; George W. Field, Sharon, Mass.

MR. BOWER: I move the adoption of this report and the election of the officers as stated. Seconded by Mr. Nesley.

Carried.

A rising vote of thanks was tendered the retiring officers of the Society and particularly to President Townsend and to Mr. Ward T. Bower who had served the Society most efficiently for several years as Recording Secretary.

PRESIDENT: I believe the report of the committee appointed to consider Dr. Smith's paper on the Fisheries Institute has not been received. Have they anything to report?

PROF. WARD: The suggestion has been made that this report should be read at dinner tomorrow, when there will be present some other gentlemen whose education in this line will be useful and may affect the report of the Committee.

It was moved and seconded that Dr. Smith's paper be re-read with the report of the Committee on the following day.

Approved.

Professor Henry B. Ward, the President-elect of the Society, was called upon to address the meeting.

PROF. WARD: Mr. President and members of the Society: I appreciate so greatly the responsibility as well as the honor which has been put upon me that I find it very difficult to say anything just at this moment regarding the matters which would interest the Society in any way. It seems to me clear, after having attended a series of meetings covering a number of years, that the Society has made a distinct advance in the last two or three years, and that this movement involves great responsibilities as well as great opportunities for furthering the interests which we represent. It will necessarily go back to the officers to determine in some

measure at least the details of the plans which the Society shall inaugurate with those objects in view. I should wish to resign the office and run away at the present moment if it were not that you have wisely and thoughtfully associated with me gentlemen whose knowledge is so much broader than my own, whose experience is so much greater, and whose success in various fields is so clear that I feel some measure of confidence at our being able together to accomplish something within the year to come.

Two or three years ago, our Treasurer informed us that we faced a considerable deficit. The membership had not increased. The Society was not able to carry on even the normal round of activities which it had followed out for a number of years previous. At the present time the deficit has been practically wiped out, the membership has been tremendously increased, and, best of all, the interest and enthusiasm of the members has been multiplied many times. No one could ask for an opportunity to go into the Board of Officers in any more propitious time than the present. I am confident that it will be possible in various ways, within the near future, to exercise an even greater influence. The hard work in building up an organization, the difficult task of supporting it through a period of unfortunate decline or standstill, is always the beginning. After the membership commences to increase, after the condition of the Society has reached the point where it is normal, activities can be carried on without danger. The gentlemen who have presided in the past have provided these conditions for the officers for the coming year.

Perhaps nothing has appealed to me more strongly, in listening to the record of this year, than the paper by Dr. Smith—the idea advanced with reference to the education of the fisherfolk along fishery lines. I shall not speak further on this, because, in the discussion that followed, a Committee was appointed for that purpose. I merely call it to your attention, to impress it more forcibly, if possible, upon the minds of every member,

that every member may be working to carry out the general idea suggested by Dr. Smith, and to advance the interests of the fisherfolk by providing such a nucleus.

I can only thank you for the kindness shown me, and ask you for your fullest and heartiest co-operation in the work of the coming year, that all the officers may be able with your assistance to advance the Society strongly on the road toward success on which it has already entered.

PRESIDENT: The chair desires to bring up another matter in regard to publication. Sometimes the papers presented at a meeting have been published by fishery journals in advance of their publication in our Transactions. Is this considered desirable by the Society?

MR. NESLEY, of New York: I believe it is desirable, because it will further instruction along the lines we are all interested in.

PROF. DYCHE, of Kansas: I do not know whether it is quite fair to restrict publication. For example there might be a journal or paper in my own locality in which I would like to publish an abstract. The proceedings of the Society may wait a year, and the usefulness of that article would be impaired if held up for that time. I would like to publish my papers in my own state, for I think they may do some good and my own people pay me for doing this work.

PRESIDENT: In some respects it would be desirable to publish parts of papers, but it seems to me that the paper as a whole should be referred to the Society; perhaps the majority of the paper might be published by permission of the author.

PROF. WARD: Should not the decision in regard to such papers be a proper part of the duties of the Publication Committee? It seems to me that in individual cases the decision must necessarily be different. I can hardly think that the Society would approve that all of every one of its papers should appear in a half dozen or more other publications before the Transactions were issued.

I move that the question as to the publication of papers otherwise than in the Society's Transactions be referred to the Committee on Publication who shall have the power to decide in the individual cases, after the consent of the author has been secured.

Motion carried.

The Society adjourned.

Thursday, September 11, 1913.

No formal meeting was held, but the members were entertained at a dinner at Nantasket, given by the Boston Fish Exchange. The paper by Dr. H. M. Smith was re-read and addresses were made by Professors Birge, Prince, Ward, Dr. G. W. Field and Col. Acklin, President of the Association of Fish and Game Supervisors.

In Memoriam

Honorary Member

DR. P. P. C. HOEK,

Scientific Fishery Adviser of the Dutch Government, Haarlem, Holland, Honorary Member since 1906. Died February 27, 1914.

Active Members

CHESTER K. GREEN

JOHN W. FREDRUM

H. D. GOODWIN

CHARLES JACKSON

PART II

PAPERS AND DISCUSSIONS

THE NEED FOR A NATIONAL INSTITUTION FOR THE TECHNICAL INSTRUCTION OF FISHERFOLK.

By Hugh M. Smith,
United States Commissioner of Fisheries.

(Read by Dr. Geo. W. Field.)

Herewith are presented some memoranda regarding the need of an institution, national in its scope, in which American fisherfolk may receive technical instruction in matters affecting not only their own material interests but also the welfare of the state and nation, through conservation of aquatic resources and improvement of methods of taking, handling, preserving, and utilizing water products.

One person in every 80 in the United States is directly dependent on the fishing industry, and yet in the entire country there is not a single university, college, academy or school where even the rudiments of an education in fishery technique may be obtained, either gratis or on the payment of tuition fees. Agricultural schools or opportunities for technical instruction in agriculture exist everywhere; but the fishing population is neglected by both state and federal governments, and private interest has not yet come to the aid of a most deserving and important part of our population. Education and instruction in the practical affairs of fishing and the dependent industries are quite as essential for the highest success and best results as in any other industry; and in some respects, growing out of changed economic and biologic conditions, technical instruction in this branch in the United States is of greater importance than in any other industry that deals directly with natural products.

This need of the fishing population for technical instruction in matters that are of vital consequence to them is recognized in various other countries (Ireland, France, Japan) where professional schools have been established

under official, semi-official or private auspices. In Japan, especially, which has become the leading fishing nation of the world in respect to number of persons engaged, quantity and value of products taken, etc., the technical or professional instruction of the fisherfolk is regarded as an indispensable factor in the industrial prosperity.

The fishermen hold the balance of power in many states, and dictate legislation affecting water products. In various states the majority of the fishermen are of foreign birth, and owing to ignorance or prejudice are not always in sympathy with conservation and other measures that are for the benefit of the community and themselves. This condition of affairs has already resulted in enormous waste of aquatic resources and loss to communities, and in some fishing regions has reached a stage where the perpetuity of an important industry and the welfare of many people are threatened.

The fishing population, even when in the most enlightened communities, are proverbially difficult to reach and influence. Their prejudices are traditional, strong and deep-set, and it is only rarely that any remedial measures for their own benefit or for the betterment of the industry that supports them are originated or strongly backed by themselves. The state fishery officials are often looked on with suspicion owing to the fear, sometimes well-founded, that increased attention from the state means increased taxation.

No greater work in the cause of conservation of natural resources can be done than to bring to the notice of the fishermen of each community, by means of personal narration and demonstration, the life history of the creatures on which their livelihood depends and the treatment those creatures should receive at the hands of fishermen and legislators. In the case of the vanishing lobster, for instance, it could be guaranteed that a course of talks and demonstrations in 50 to 100 communities in New England would so educate the fishermen and produce such a change in sentiment and prejudice as to lead to immediate ameliorative measures in every

state, resulting in the speedy restoration in abundance; whereas, at the present time, the fishermen, in their ignorance of even the elementary facts in the life of the lobster, are backing measures and practicing methods that are most destructive and foolhardy.

A tentative plan for an institution for the imparting of practical technical instruction to American fisherfolk may be outlined as follows:

I. OBJECTS:
- a. Gratuitous instruction in fishery matters, adapted to local needs and conditions, and intended to render the fishing operations more effective and remunerative.
- b. Practical conservation of the fishery resources of every region, resulting from an appreciation by the fishermen of the vital needs of the creatures sought.
- c. The creation throughout the country of a corps of well-qualified persons who are able,
  - (1) To direct large industrial fishery operations and shore branches connected with the fisheries (as salting, canning, and smoking plants).
  - (2) To become technical experts in the administration of the fishery services of nation or state.
  - (3) To engage in or take charge of national or state fish-cultural work.
- d. The gradual improvement of the morale of the fishing population, the placing of fishery work on a higher industrial plane, and the removal of purely economic fishery questions from local politics.

II. SCOPE AND METHODS:
- a. Instruction of the fishing population (including women and girls) to cover the following subjects: Fishery methods and apparatus; preservation of water products for food, fertilizer, in arts, etc.; fishery legislation, protection and regulation; fishery administration; fish culture, adapted to government, state, and private operations, and applied to fish, shell-fish, frogs, etc.; aquatic biology and physics; utilization of waste products; conservation; navigation, etc.
- b. Instruction to be by means of lectures, practical demonstrations, printed matter, and correspondence.
- c. The affairs of the institution to be conducted from a central bureau and through the medium of special courses of instruction in numerous communities in charge of corps of experts, who may visit place after place in regular order.
- d. The leading specialists in every branch of national, state, and private fishery work to constitute the nucleus of the faculty; and all existing facilities for study and practical work to be availed of.

DISCUSSION

PRESIDENT: This is a very important paper and I am in a position to state that when Dr. Smith made his visit to Japan he visited the very extensive fisheries institute of the Imperial Government of Japan, and it made a profound impression upon him. There is no-

where, in any other country, an institute of that kind. They teach almost all the branches connected with the fisheries, fish culture and marine biology, and it has frequently occurred to Dr. Smith that such instruction is needed in this country. We ought not to let the Japanese get ahead of us in this respect. Japan has been called the paramount fishing country, but the United States is one of the next, and it is to be hoped that we may see something like this in our own country.

MR. JOHN P. WOODS, of Missouri: This suggestion has been presented in a very learned way in the paper we have just heard read and we should take special cognizance of it and act on it in whatever way may have the best effect. It is a very important matter and I move the appointment of a committee to consider it.

Approved.

PRESIDENT: I will appoint Messrs. Wood, Dyche and Prince, and will ask them to report at a later period of this meeting.

MR. JOHN W. TITCOMB, of Vermont: Commissioner Smith has referred to a forward movement in agriculture. Something like a thousand elementary schools in agriculture have sprung up in the last ten years. In our State we have a movement which provides for associations of farmers and those associations are employing county agents, supposed to be experts, who go about among the farmers to learn of their conditions. It seems to me that this paper contemplates something similar in a fishing community, and if it does as much good as this movement among the farmers is doing it will help tremendously in forwarding the work of the fisheries and will be of great economic importance.

Fish culture has also been touched upon. I think Dr. Smith feels that we should have experiment stations. We have none today. We have fish culture stations, but not experiment stations, where we can try out theories, and I hope that will be included.

DR. E. E. PRINCE, of Canada: I noticed a reference to Ireland in Dr. Smith's paper. I think Ireland preceded Japan in regard to education in fish matters. The Baroness Burdett-Coutts, forty years ago, provided the funds to found a fishing school for the purpose of instructing the Irish fishermen in the arts of fishing, use of bait, and, in brief, their fishing operations. The school was carried on by a priest, Father Davids, who arranged courses of instruction. When I visited the station, about twenty years ago, the fishing population were not thoroughly enthusiastic and the school was not so successful as it had been.

Another movement in Scotland, a little later, was started by the University of Edinburgh. Courses of instruction were given on fish life and on fish matters generally, and there again the Scottish fishermen did not take that intelligent interest in the work that was expected. I, myself, took part in a course of lectures upon fish matters, under what was called the Summer School of Science, and we hoped that the fishermen of the neighboring fishing towns were being benefited. I think when the fisherman left the lecture he felt that there was not very much to learn from the professors.

The point is how best to get at this work to make it successful. In the first place a little missionary work is necessary; and, in the second place, that work must be done by visiting fishermen themselves in the fishing towns. Fishermen, as a rule, are rather suspicious of instruction from scientific men, and in some respects perhaps they are right. The fishermen expect to learn all they can about catching fish. They do not find much instruction in that, but if their interest could be aroused in regard to conservation, there are many sources of waste

which could be stopped at once, and the result would be to benefit the fisheries.

A very distinguished statesman in Britain once asked me to lecture in the North of England. I went to six or seven fishing towns and talked with the fishermen and found that my addresses were quite a success, but I did not quite understand the reason. It was explained to me that it was because I said in my first lecture that I wanted the fishermen to understand the fish, and I began by describing, amongst other things, the ears of the fish. The fishermen had no idea that the fish have ears. The Government stopped their guns being fired close by, for they said that if the fishes had ears, the big guns must be removed, which helped my cause. Of course, it was not my object, but the interest of the fishermen was aroused, and the first step must be to interest the fishermen.

A few weeks ago, at one of the biological stations in Canada, on the coast of New Brunswick, we visited some fishing towns in the course of scientific inspection, and in one little town of fishermen we were asked to arrange for addresses, a movement which came, I think, from the fisherfolk themselves. They suggested that while we stopped in this village we might put in some of our work in investigating deep-sea fisheries. We did so. It was good experience, and it was also a very great pleasure to find a crowded hall and the fishermen exceedingly interested in fish, young fish, eggs, etc.

So there is quite an opening for work of this kind, but if approached from the other side, the technical, college or university side, or by a course of lectures, you will not get out the people who really need to be instructed.

PRESIDENT: I do not think that people realize what a vast amount of inquiry respecting the fishes and fisheries has grown up in the United States Fish Commission. Those of you who have not been connected with the Commission do not know what a tremendous correspondence the United States Bureau of Fisheries has to handle. Everybody gets the best answer that the Bureau can give and the letters go all over the land to the American people, answering their inquiries; they include letters from common people, letters from fishermen who want to know the best way of selling; letters from those who want to know the latest results in regard to sardines; letters from those who want to know about salting fish; letters on all kinds of fishery work.

Now it has seemed to me that a great deal could be done if we could get together and teach men who would be willing to lecture to the fishermen. We cannot always get at them in the cities, and large cities are pretty well supplied with lectures of various kinds, but I am quite sure that somebody that knows about fish, lobsters or oysters, that could go to fishing centres where these are vital matters, would get a good audience, and such a man would be able to impart a great deal of useful information to the fishermen. Just how we should go about the founding of an institute of fisheries it is hard to say, but after our committee has talked this over we shall be very glad to hear their recommendations.

A PERFECT FISH PASS

Some suggestions as to Defects in Fish Passes and how to Overcome Them.

BY PROFESSOR EDWARD E. PRINCE, LL.D., D.Sc., *Ottawa, Canada, Dominion Commissioner of Fisheries and Representative of Canada on the International Fisheries Commission under the Fishery Treaty of 1908.*

Fishery authorities are practically agreed that the decline of salmon in most countries is due, more than to any other cause, to the blocking of rivers and lakes by dams, artificial barriers, etc. No one can doubt that overfishing, injury to spawning beds and fifty other unfavorable circumstances, have had small effect compared with the completely destructive character of dams and the like. Shad, alewives or gaspereaux, sea trout, striped bass, and other valuable fish, have also become practically extinct in many localities where they once abounded, all from the same cause.

FISH SECONDARY TO INDUSTRIES ON RIVERS.

Lumber mills, electric power houses, grist and granite work, pulp factories and other active enterprises, which more or less vitally depend upon water-power, have ruined some of the finest rivers in the world by entirely blocking them with dams and huge barriers. A lovely salmon river that was worth to the locality (in Nova Scotia) probably $50,000 per annum, was ruined a few years ago by the erection, not of one, but a series of dams in connection with the wood pulp industry and on a protest being raised, a prominent leader in the country replied, "$50,000 worth of fish must give way to $5,000,000 worth of industry."

INGENUITY AND NUMBER OF FISH PASSES.

No wonder that to overcome this grave trouble, ingenious and zealous minds, in almost every civilized country,

have devoted time and great powers of mechanical genius, as well as vast practical experience of fish and fishing, to the subject of fish passes. Not only engineering and mechanical skill, but much scientific knowledge has been brought to bear on this fishway problem. There are probably three hundred kinds of fish passes in existence, differing endlessly in regard to details, but grouped as I have shown in a report published in 1902, under about 16 or 18 headings acording to the essential principle embodied in their design.*

PURPOSE OF FISH PASSES.

Now it will hardly be disputed that a Perfect Fish Pass should enable such a number of fish to ascend at their special time of migration, and to reach their accustomed breeding grounds, as to restore and permanently maintain their former abundance.

RESULTS DISAPPOINTING.

Salmon rivers on this continent, and in other countries, formerly produced every season vast numbers of fish, but it must be confessed that the building of fishways at great cost and the efforts of fish culturists have in no instance brought back the fish to their pristine plenitude. In the case of shad, alewives or gaspereaux, striped bass and other anadromous species they have not been restored, even to a moderate degree, in many rivers personally known to me. Indeed these fish are on the verge of extinction in spite of all the exertions of hatchery officers, of governments—state and federal—of fish and game clubs, and the true friends of fish generally. It is plain that no hatcheries can really benefit a river to the fullest extent if the fish are cut off from access to the upper waters. No salmon river can resume its pristine productiveness if one or more dams block all access to the best pools and spawning shallows.

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*Canada, Marine and Fisheries Report, "The Fish Way Problem," E. E. Prince, pp. LXXI-LXXVIII, 1902.

MOST FISH PASSES HAVE FAILED.

In common with my brethren in the national fishery services of the various countries in which we live, I have given much attention for many years to this subject, and what is the conclusion to which I have been compelled to come? I may state it by saying that a few days ago I remarked to one of the most eminent fishery authorities on this continent that "mill dams had done more harm than any other injurious cause," and I added "my reply to you if you put the question"—Is there a fish pass or fish ladder known to you which is a complete success in enabling large quantities of fish to ascend?"—my reply, I say, would be "I do not know of such a fish pass." And my distinguished friend, a man of very vast experience, said, "Well, Professor Prince, if you asked me do I know of a fish pass completely successful in enabling fish to ascend over obstructions such as mill dams, I would say, 'I do not know of such a fish pass.' My friend fully confirmed my own serious conclusions and I need hardly say that I speak from a very unusual experience, for I have examined numerous fish passes or fish ladders in various countries—in the British Islands, where immense sums of money have been expended by wealthy noblemen and other private owners of salmon rivers, in England, Scotland, Ireland and Wales; and no man knows better than I do the salmon rivers of North America, both on the Atlantic and Pacific coasts of Canada and the United States, and even where some success has been achieved as in the massive structures of masonry and concrete in Britain, the result is not equal to reasonable expectations. Rigorous tests made have shown that fish passes are, in general, a sad failure. One I know in Quebec Province cost $15,000 and never a single fish ever used it, and another not very far from Washington, D. C., costing $17,000, has never been proved to have enabled one fish to get up. On a Nova Scotia river, to give another Canadian example, a net was arranged at the upper entrance of a fish pass, which was arranged so as to capture any fish passing up the

fishway, but the officer reported that no fish were actually taken in the net; one fish was believed to have got up and escaped from the net; but that was not very certain. A similar test was made not long ago by the Fisheries Bureau at Washington, with a similar result, no fish appeared to have found their way into the pass, nor ascended it and been taken in the net at the upper entrance. It is said that "One swallow does not make a summer," yet I am really prepared to admit that one fish would prove a successful fishway. One clearly proved case of a fish ascending and finding its way to the waters above the fish pass would, to my mind, silence criticism.

TWO MAIN FEATURES IN FISH PASSES.

What are really the difficulties? If we can decide what the defects of existing fish passes are, we can try to overcome them. No doctor can be expected to cure a disease unless he had made a diagnosis, and decided what the disease is. Most fish pass specialists have confined their chief attention to two points: (1) Strength and durability; (2) Reduction of the force or momentum of the water coming down through the fish pass. The first was important because ice and tremendous floods, and floating trees and logs, would injure or carry away a lightly built fish pass; and the second is likewise important because shad and alewives, and even salmon, cannot work their way up a cascade of water of very great momentum.

DEFECTS OF FISH PASSES ENUMERATED.

I think it will not be disputed that most fish passes have one or more, or perhaps all, of the defects I now mention:—

(1) Ice in winter damages or even destroys them.

(2) Floods in spring make them useless—tearing parts away and filling them with debris.

(3) At some seasons too much water, at other seasons too little or even none at all, make them ineffective.

(4) The entrance is usually too small to be found by the fish.

(5) The entrance is in an unsuitable place and may be ten, twenty or even fifty yards below.

(6) If covered, the fish pass is dark, and fish prefer to jump at a glittering waterfall rather than enter a dark box or suspicious closed trap.

A NEW FISH PASS DEVISED IN CANADA.

Now, gentlemen, I have been at work designing a fish-pass to overcome all these defects, and I had hoped to have a model and drawings here today. The main idea of this pass,—I shall call it "THE PERFECT FISH PASS," if it possesses all the advantages I claim for it,—has been in my mind for ten or twelve years, but only during the past summer have I actually erected one, a large model on a small stream in New Brunswick, where a natural fall or obstruction of nine or ten feet exists. My good friend and scientific colleague, Prof. A. P. Knight, joined me in this experiment and we succeeded with the idea excepting for two or three small details which troubled us for some time. We tried repeatedly to get over these small difficulties, but in vain. Hence my play of "Hamlet" today gentlemen, is the play with Hamlet absent. I decided, however, to bring the subject up even though I shall not have the satisfaction today of showing you the model and the drawings to scale. Prof. Knight has these, as he continued the observations of the model on the New Brunswick stream, after I left on a visit to Washington, and he wrote me since I left. "Its success," he says, "has been greater than I expected," and he adds in the same letter, that he has now no doubt "it will prove even more successful than you (that is, myself) had ever anticipated. In my humble judgment," he says, "this fishway will rank next in importance to the enforcement of adequate fishery regulations . . . . as a means of conserving fish-life."

Not only has the model over ten feet high worked well, but I had arranged for a far more conclusive test at

St. George's Falls on the Magaquadavic River, New Brunswick, this summer and fall. Some official delay arose and the pass could not be erected in time to enable salmon to use it.

TEST AUTHORIZED IN NEW BRUNSWICK, CANADA, AT ST. GEORGE.

The falls are 31 feet high, quite perpendicular, and at the head of a long, deep, narrow gorge or canyon, full of jagged rocks. Salmon every year get up the gorge and jump at the high falls, but none have ever, I fear, succeeded in getting up. I regard the place as one of the most difficult to be found, and selected it owing to my confidence that this perfect fish pass will succeed where every other fishway must fail. Had I been permitted to carry out my plan, I have no fear that it would not be a complete success; but it was possible only to prepare the materials this season and even if erected in September or October, salmon will not use it, for they ascend early and are seen jumping in July and August, or even in June. The Dominion Government has provided the money to cover the cost of this first Perfect Fish Pass, being apparently most anxious to at once adopt this pass. The case of this river will be even a more important success than on the rivers I have already referred to. The Magaquadavic River, though resorted to by salmon, year after year, is closed by the precipitous falls at St. George only a few hundred yards from its mouth. No salmon have ever got further up. Hence the success of this fish pass would create a new salmon river. A successful fish pass would not only restore rivers destroyed by artificial dams; but would open up waters hitherto inaccessible and therefore destitute of salmon owing to impassable falls. I shall test next year two remarkable rivers up which salmon ascend only a short distance. On one of these rivers (in Cape Breton) an obstructing fall exists not more than three or four miles from the sea, and the late Inspector Bertram informed me that he had seen 1,100 or 1,200 salmon in the

pool just below the fall, not one of which could get up any further. I visited for the fourth time recently a famous salmon river in northern New Brunswick, up which the fish ascend for twenty miles, and then are blocked by lofty falls. The pools are few and the spawning grounds very limited, much of the twenty miles consisting of narrow rocky channels and gorges; but above the falls there extend for sixty miles the most perfect salmon waters, clear, transparent, rippling water, superb pools and riffles ideal in every way for spawning, and for the finest fly-fishing. Thus a river affording less than twenty miles would be converted into one of eighty miles and a far superior river by the erection of the Perfect Fish Pass at the upper falls.

THREE NEW FEATURES: A LEADER OR WING, A LARGE ENTRANCE AND PORTABILITY.

I do not wish to repeat myself, but as my Perfect Fish Pass may be found to be capable of meeting difficulties which I have overlooked, I trust that such difficulties will be mentioned here today. My object is to elicit a discussion and to hear of the experience of others, and I will close therefore by referring to a few of the features which will be found in this Perfect Fish Pass:

(1) To be of any use a fish pass must be found by the fish. The fish *must* find the entrance to the Perfect Fish Pass because a wall of wire netting, a "leader," is part of the design and stretches across the channel and guides the fish to the opening, just as salmon and other fish are led or guided into a fish trap.*

(2) The entrance is not small, dark or forbidding, but large and open and admitting all the light possible, hence no fish will be deterred from entering. The small entrance and narrow aperture in the successive compartments in most fishways are necessary to reduce the down-rush of water, to economize the water, and lessen

*Most every existing fish pass is correctly named because the fish do pass it and fail to find it.

the momentum, but this is overcome in the Perfect Fish Pass.

(3) No ice or floods can damage it or interfere with it, and why? Because it is not there when the ice forms and when the freshets and floods pour down. Fish do not ascend streams after the ice forms, hence this new fish pass has been made portable. It is taken to pieces and removed for storage during the winter, as during that season it is of no use on the river. I asked a famous writer on fish passes how many months per year salmon, in his opinion, would use a fish pass, and he said "four months cover the main period," yet for four months actual use, fish passes are in position for twelve months, but the Perfect Fish Pass is so constructed and pieced together by strong brass bolts, etc., that it can easily be taken away in a few hours, and thus runs no risk of damage in winter or early spring. Salmon may ascend, for example, from June to November, but the most important run is during four months, say, July, August, September and October. The fish pass is in position and available then, and the few fish, before or after that period, can be neglected. These few fish must come up next year. "Too late, too late," the Perfect Fish Pass seems to say, "Ye cannot enter now, but you can come again next summer." The salmon supply for the future in any river is secure, I claim, if the main run are enabled to ascend during the period referred to.

One point before I close: It was my intention to place freely at the disposal of the Canadian Government this new device; but the official attitude assumed at headquarters questioning the granting of any authority to erect the first fishway on this new principle caused me to change my mind and in justice to Professor Knight, and in the interest of an engineer who aided me on some technical points I completed steps to protect it by patent. Such protection has been granted in Canada and has been applied for in the United States so that my fishway is not only as I hoped and claimed, entitled to be called "A Perfect Fish Pass," but it is what I had not originally intended or claimed, it is a Patent Fish Pass.

DISCUSSION

MR. N. R. BULLER, of Pennsylvania: The question of a fishway is one of the nightmares to the Commissioner of Fisheries of Pennsylvania and has caused us a great deal of thought and study in the past two years. The Susquehanna River has always been a shad river until two years ago, when the Carlbury dam, sixty-five feet high and three-quarters of a mile in length, was completed. There is a Kale fishway placed in the dam, but, on examination of the dam, carried on during the migratory season of the shad for three days a week, we failed to find one fish that had entered that fishway. After finding that the Kale fishway has not been satisfactory, the power company has started and nearly finished a fishway from plans furnished by the Department. That is a natural way, sixty feet wide, following down over the breast of the dam, widening out to a hundred feet where it catches the trend of the river, and is built of concrete and large boulders. This power company has met the Department of Fisheries more than half way at every request made of them, for I assume they want to put more dams in the river. We are very anxiously awaiting next spring to see whether this fishway will be adequate or not.

MR. JOHN W. TITCOMB, of Vermont: I want to ask Prof. Prince about taking down and putting up the props. For instance, I want a fishway to take care of the spring spawning of the fish. In that case, on account of heavy freshets just at the time of assembling, the fishway would have to be installed in the fall, and if installed in the fall to carry it through the freshet period, it might as well be there the year through.

PROF. PRINCE: The fish pass is not put up until about to be used. Instead of being actually where the fall is, if necessary it could be put in a quieter place, 50 or 100 yards below, and a channel made so that when the fish have got up to the pass they will go along the channel over the dam.

MR. TITCOMB: That would have to be put in in the fall; you cannot do work of that sort in the spring with a freshet of two or three feet of water flowing over the dam. I am very sceptical about this matter, and I think if there are fishways supposed to be practical for commissioners, to expend quite a little money, if necessary, to find out whether they are doing anything or not. One year, the Connecticut River had a fishway put in costing $60,000 and not a fish went through it.

PROF. DYCHE, of Kansas: In Kansas the Legislature passed a law four years ago, making it obligatory that dams be furnished with fishways and giving about six months to effect this. They called upon me to furnish plans. I got two or three good engineers to assist me, and finally, we got plans for a fishway which are published in the proceedings of this society. Then I built about a dozen or fifteen of these fishways.

To make the fish start through the fishway basin has been a failure. I wrote a public letter stating that I had been unable to build a fishway that was adequate, and that I didn't think it was fair to require owners of dams to build fishways when I could not guarantee them to be of value after they were built. The people living above these dams are sending in petitions and worrying about the fishways.

We have one fishway that the fish do go up. This was built by Wells, State Engineer, and myself, at Wichita, Kansas, where a dam was across a little river with three feet extra rise; when the water was high, it was let down; when low, it was lifted up.

We made this fishway of cement, to run up as far as the outlet. We dug down fifteen feet deep and brought the fishway around underground. The part that is underground is built of cement, but where it comes out it is of steel structure, which it is possible to remove during that part of the year when the fish are not in the stream. We found that catfish were going up right along. It was necessary to have a door made which could be locked to keep the fish from going up except when we had control, in order to keep poachers off.

MR. A. H. DINSMORE, of Vermont: One of the most serious problems any one has is in connection with the salmon fisheries of the Pacific Coast. I want to ask Professor Prince if his plan is adaptable to the conditions there. Does he plan to put in a temporary wire barrier to stand when the fish are running? In the spawning of salmon on the Pacific Coast they always crowd at the flood periods.

PROF. PRINCE: I think it will work there. I claim that no fish pass erected for the flood period is good in low water. This pass would be erected before the flood season and would be adapted to those conditions. One of its chief points is that it can be taken down.

MR. SEYMOUR BOWER, of Michigan: My experience in Michigan is very much the same. We have a law which requires the provision of fishways, but as far as I know they are an absolute failure. It seems to me that one remarkable feature of Professor Prince's fishway is the leader to guide the fish to the mouth, but I would like to know what material he uses, and how he is going to prevent the leaders from being carried away. In our state the question of testing fishways is going to be a very important one owing to the fact that rainbow trout are multiplying and eventually will be a very important commercial fish in the Great Lakes. In six streams that flow into Lake Michigan there were half a million to a million pounds of rainbow trout headed upstream toward the dams, and the number seems to be increasing rapidly, so the necessity for adequate fishways is of very great importance.

PROF. PRINCE: The full description of this fish pass, with drawings, is being printed, and I propose to send every one here a copy. The leader is one of the most important features. Its permanence is of no importance. It is made of chicken wire, and if carried away can easily be replaced.

MR. W. C. ADAMS, of Massachusetts: The Indians in the West have shown us how to lead trout by building a rock wall two to three feet wide across the stream. The fish do not rise over this wall, but are led right to the fishway. We have one dam thirty feet high with a fishway consisting of a series of wooden boxes six feet long, four feet wide and four feet high. In this fishway I have seen twenty tons of trout waiting their turn to go over and running from box to box. We have taken out at this place as high as 5,000 spawn trout yielding twelve to fifteen million eggs. A wire leader would break down here with debris, for the fish go up only in the flood season; but with the rock wall under water, which the Indians showed us how to build, the debris passes over while the fish are led to the way. We have had such success with this method that we consider our problem solved.

PRESIDENT: The experience of Fish Commissioners is that the automatic fish pass is a failure. Perhaps the fish could be locked in dams like a canal pass, with very long locks which could be opened and closed as often as necessary.

SOME ANIMALS AND CONDITIONS INIMICAL TO FISH EGGS AND LARVAE IN THE SEA

By Professor Edward E. Prince, LL.D., D. Sc., Etc.,
Commissioner of Fisheries for Canada.

As one of the pioneers in the study of the eggs and young stages of marine food fishes, I remember an opinion expressed long ago by high authorities that the sea might be over-crowded with fish were there not some effective means in existence for checking their increase.

COD AND OTHER MARINE FISHES MOST PROLIFIC.

At that time the number of species of marine and fresh water fishes, exclusive of sharks, etc., known to science, was about 12,000, and as I stated in a paper on fish eggs published in 1886, the eggs of not more than 80 species had been discovered and described.* At the present time over 100,000 species of Teleosteans are known to Ichthyologists and the eggs and something of their larval development are known of about 350 species. As long ago as 1864, G. O. Sars in Norway had shown that cod, mackerel, haddock and, I think, gurnard (*Trigla*) eggs, floated near the surface of the sea, and J. A. Ryder and others in this country, McIntosh in Scotland, G. Brook, J. T. Cunningham and others in England, proved the same thing of these and a number of other species, and pointed out that the eggs were produced not by thousands, as in the case of salmon, trout and herring, but by millions. Their eggs were stated to be not large and heavy and deposited on the bottom of the water; but quite minute, almost microscopic in size (30 or more in a row extending barely over a linear inch) and so transparent as to be nearly invisible, while their small specific gravity caused them to float near the surface of the sea. The number of eggs produced annually by most of the important marketable fish to which I

*On the Presence of Oleaginous Spheres in the Yolk of Teleostean Ova. Annals of Natural History, London, 1886.

have referred, is so vast as to be almost beyond human comprehension.

PARENT FISH MASSED ON SPAWNING GROUNDS.

The young fish hatched out in localities, known as sea-fish nurseries, resemble in their myriads the clouds of mosquitoes in a vast marsh. This is easy to understand when it is remembered that in such areas as the Canadian fishing grounds on the Labrador Coast, and on the banks of Newfoundland, the spawning cod assemble in such crowded schools that even steam vessels find themselves impeded when moving through them, and one of our Dominion officers referred to this a few years ago, almost repeating the words of Jacques Cartier, three centuries before, who found it no unusual thing to have the wheels, or rather keels of progress in the sea, blocked by these schools of breeding fish, crowding the surface waters where they were schooling; and Dr. Wakeham, one of the most experienced of Canadian Fishery Inspectors, has referred to this same feature, viz: the difficulty at times of navigating through the massed myriads of cod when schooling.

FLOATING FISH EGGS EASILY KILLED.

I found in my early studies and experiments that floating fish eggs in the sea are very sensitive to unfavorable influences. On the other hand they seem to be indifferent to many influences that might be thought equally detrimental. A fisherman putting his hand smeared with paraffin oil into a tank of cod eggs caused the death of many thousands, as a film of oil spread over the water and seemed to coat each minute egg and suffocate it.

I once lost some valuable jars of hatching mackerel eggs by a shower of soot from the funnel of a Government Survey steamer descending at a most inopportune moment. That was in 1892, in Ireland, when I was the first, I believe, to hatch out larval mackerel, and I had completed some drawings and descriptions but wanted the stages a little older. My work was spoiled, for the

soot persisted in clinging to the floating eggs, and Mr. J. T. Cunningham and others published results which they made later than my hatching experiments and thus had priority.

Chemical and physical changes in the surrounding water affect fish eggs harmfully. Many of you have read Dr. Knut Dahl's interesting paper on the problem of sea fish hatching (Conseil Intern, pour l'Exploration de la Mer. Rapports et Proc. Verb. Volume X, April, 1909). Hansen had found long ago vast numbers of dead pelagic eggs on the bottom of the sea and Dahl no doubt found the reason for this, at any rate in the condition in certain Norwegian fjords where he says deep layers of water remain unchanged and stagnant, saturated with sulphuretted hydrogen and devoid of oxygen and showing the absence of higher animal forms.

FLOATING EGGS SINK AND MAY DIE.

The varying specific gravity of the water also affects pelagic eggs in a remarkable degree, and in March, 1905, Dahl says that at 2 meters (78 inches or over 2 yards depth) he got 12 eggs at one Station, 26 eggs at 5 meters, 610 eggs at 10 meters, and 1190 eggs at 30 meters; possibly owing to fresh water at the surface, the cod fry at the same depths were respectively 1, 4, 62 and 76. In the southern waters of the Norwegian coast cod eggs and larva will float in still water of an absolute specific gravity of 1,021, but if below that they sink down lower and lower.

Again, winds, currents and tides affect the floating eggs so that vast numbers not only drift far from their original localities, but may even be washed ashore and destroyed. It is on record that flat beaches have been noticed glistening with untold millions of these minute glassy globes, the eggs of cod, haddock, etc., just as Professor McIntosh found in Scotland a long beach strewn with the delicate needle-like *Sagitta* after particular storms and winds.

FLOATING FISH EGGS SURVIVE SOME PECULIAR CONDITIONS.

But curiously enough these delicate eggs will resist some most unfavorable environments. I have seen a stone jar with cheese cloth over the top, filled with cod eggs floating in sea water and arriving after a long journey of several hundred miles in fine living condition, though a strong putrid odor was perceptible and the water was foul with decayed animal matters.

I have kept floating eggs in watch glasses or shallow glass dishes, and they lived and hatched out, and the young larval fish survived for some days, though the water was becoming more saline daily through evaporation. Professor McIntosh, long ago, told of an experiment with floating eggs in a test-tube which he heated until the contents were almost boiling, and he laid the tube aside only to find accidentally, a few days later, that the young larval fish were actually swimming about.

PELAGIC FISH LARVAE AND CRUSTACEA DEVOUR EACH OTHER.

There is no doubt that fish eggs form a part of the food of many vertebrates and invertebrates in the sea.

The older fish often gorge themselves with eggs and fry; but as Professor Fabre Domergue of the Concarneau Laboratory has said, in his beautiful monograph (Development de la Sole, Paris, 1905), the young fish, after the yolk has grown, become most active hunters after other fish and attack even larger larvae than themselves. At first the victim may escape, but after many repeated attacks, they rarely miss their prey. The victim, as bulky and as long as the hunter, cannot be swallowed at a single gulp, but one sees the tail wagging actively as it protrudes from the mouth, and so transparent are the fish that the victim can be seen passing into the gullet and then into the stomach. "Total deglutition," says Fabre Domergue, "may last more than an hour, and one may constantly have passing under one's eyes, undeniable proof of their appetite for the tail of the victim protudes more or less from the jaws. It can be best described as giving the impression that

the young fish seems to be smoking a pipe. Little by little the prey is swallowed and disappears."

I have seen young fish, one-fifth of an inch long, swallowing Copepods more than half their own length, and the antennae and swimming feet could be observed protruding for some time from the mouth of the devourer, On the principle of *lex talionis,* the Copepods make war upon the larval fishes, though probably only upon those that are weak and in a moribund condition. It is true that I noticed a bright green Copepod in Irish waters over 20 years ago that seemed to attack floating eggs; but I had not the time or opportunity to ascertain to what extent this might be the case. On numerous occasions, however, I have found *Temora, Calanus, Oithona* and other species of Copepods, abundant in New Brunswick waters, making short work of dead larvae of various fishes. So rapidly do these minute crustaceans do their destructive work that unless minute organisms, removed from the townet, are placed in preservatives, only small fragments will remain, especially of young fishes. I have not actually seen Copepods attack living fish-larvae of the minute types occuring in the surface waters of the sea.

MEDUSAE AND OTHER JELLYFISH KILL FISH LARVAE, ETC.

There is, however, clear evidence of the destruction worked by certain jellyfish. Professor McIntosh, of St. Andrews, Scotland, long ago described and figured a Ctenophore, *Pleurobrachia,* swimming downwards in the sea and engulfing a larval crab (in the zoea stage) and later in his book, jointly issued by Dr. Masterman and himself, he gave a figure of a Ctenophore which had captured a larval fish, whose head protuded from the mouth or manubrial aperture, though the body and tail were partly digested.

In 1888 Professor McIntosh described a small medusa (*Thaumantias*) as most predaceous and so "greedy that it engulfs post-larval fishes and thus it is necessary to remove them from contact with the Cydippes at the

moment the floating townet is brought on board," while in his "Resources of the Sea" he specially mentions "the tax levied by jellyfish and Coelenterates generally upon animals in the sea as high in the scale as fishes." Dr. V. Hensen in 1883 claimed that "the small *Sarsia tubulosa* measuring only 1½ centimeters eats fish eggs. I had placed a small number of eggs with broken yolks measuring on an average 1. 2 mm. in a glass vessel into which a specimen of *Sarsia* had accidentally found its way. Several were missing later and the gastric chamber of the *Sarsia* was swelled out considerably." The peculiar creeping jellyfish, the ambulatory gonozoid of *Clavatella prolifera* discovered at Torquay, England, by the eminent zoologist, Rev. Thomas Hincks, is described by him as an agile climber at one time using its suctorial discs as feet, and moving with ease up the perpendicular sides of a glass vessel, at another employing them as hands, and climbing amongst the branches of seaweeds. DeQuatrefages described an allied creeping medusa *Eleutheria* which drags itself with difficulty over a smooth surface; but displays considerable activity as soon as it reaches a tuft of sea weed. *Eleutheria* keeps the mouth turned upward when it moves. *Clavatella* on the contrary always carries it below.

Now, it is well known that young fish live commensally as boaders, so to speak, with some jellyfish. Many observers have noticed this. Dr. Knut Dahl, indeed, tells us that he saw in the Skagerrack, the pelagic young of cod, haddock and whiting in great masses, drift past under jellyfish at a speed of 3 to 4 knots. The sea was quite full of jellyfish and under nearly every one of them swam one or several young fish. All the jellyfish or medusae are not so hospitable, and I have made a special study of some cases of destruction of young fish by small medusæ. If, as I have reason to think, vast numbers of these creatures devour fish as part of their food the loss of young fish must be very extensive.

IMMENSE ABUNDANCE OF JELLYFISH.

A few weeks ago I passed in a small scientific launch through countless masses of jellyfish (chiefly *Aurelia*) in Passamaquoddy Bay. The numbers of various species are often almost beyond belief, and in the State of Connecticut, some years ago it was stated that shad fishing was stopped by the jellyfish whose hordes literally swept away the nets and stakes like an onrushing army.

Dr. Richard Rathbun in his report on Pacific Fishing Banks (United States Fisheries Bureau Report, Part XVII, 1893) says of Slime Bank in Bering Sea: "This bank derives its name from the occurrence of immense numbers of a large jellyfish, brownish or rusty in color, and provided with long slender tentacles, having great stinging powers. These jellyfishes, it is said, have never been observed at the surface, but seem to occupy an intermediate zone toward the bottom, where they occasion much annoyance to the fishermen by becoming entangled about their fishing gear, and in this way are often brought on board the vessels. It is also reported that sometimes they even interfere with the hooks reaching bottom, and, by covering the bait and lines with a prickly slime, render the former unattractive to the fish and the latter very uncomfortable to handle. In the early part of the season not much trouble is experienced from this cause, but by July 1, the jellyfishes become so thick that it is almost useless to remain longer upon the bank, and other localities farther north are then resorted to. Except for this unusual phenomenon, however, the advantages for fishing on Slime Bank are excellent. The largest and most thrifty looking cod were taken by the *Albatross* some 6 or 8 miles from shore, but fish of fair size and good quality were plentiful over nearly the entire bank. Small specimens of halibut were also secured occasionally, and the beam trawl disclosed a rich bottom fauna. Attempts have been made to use cod trawls upon this bank, but without success, owing to the obstacles which the jellyfishes interpose."

HOW MEDUSAE KILL FISH.

It is remarkable how few cases have been observed of the actual seizure and digestion of small fishes by medusae. This lack of observations, in view of the vast abundance of jellyfishes in most seas where small fishes abound, is astonishing, and adds, I think, to the interest of the study which I shall briefly set forth. At Canso a few years ago I captured a young *Obelia* less than a half-inch in diameter which had captured a small fish more than half an inch long. *Obelia* has no long tentacles for seizing prey and its hanging manubrium, with mobile mouth opening, is not specially well-adapted to grasping active living creatures such as fishes. Yet I found that this specimen had not only caught a small fish, but that it was nearly masticated and digested, and only the head and the bright metallic eyes were recognizable, barely protruding from the mouth. Apart from the squeezing action of the manubrium the pulsations of the medusa enlarged and diminished the capacity of the radial gastro-vascular canals, the pumping, or rather, suction action aiding in breaking down and tearing off fragments of the body of the larval fish which had been ingested tail first. Now it is well known that the oral and gastric endoderm cells copiously pour out a secretion which has the action of a ferment or solvent upon food materials. A process of digestion commences as soon as an object like a small fish passes into the manubrial aperture. The food is broken down by mechanical pressure and squeezing, and is mingled with the ferment and sucked inwards. Particles of the fish could be seen passing into the fundus of the gastric cavity whence four radial canals pass off to join the circular marginal canal. The endoderm of these canals is ciliated, though sparsely, causing a circulation of the watery gastro-vascular fluid in which float the macerated food particles and the dissolved liquid elements. Intra-cellular digestion, as Metchnikoff and Ray Lankester found, takes place over limited areas of the internal walls, but the nutrient matters are probably not transferred to the deeper tis-

sues osmotically, to any large extent. Most of the dissolved food, digested intra-cellularly, appears to be returned to the alimentary system and carried by the gastro-vascular canals to remoter parts.

I cannot, however, go into details as to the anatomy and physiology and the minute histology of this interesting phenomenon of the digestion of small Teleosteans as observed by me in the jellyfish. I am publishing elsewhere an elaborate paper on that subject. All that is necessary here is to state that the destruction of young fish in the sea by medusae has been demonstrated, that the fish seem to be seized tail first by the prehensile manubrium, masticated in the gastric chamber and dissolved by gastric solvents while the pulsations of the bell-like or umbrella-shaped medusa, driving it through the water, produce a squeezing and sucking effect most effectively macerating even a large object like a fish half an inch long. The circulation due to cilia in the gastro-vascular canals, the digestive ferments, and intra-cellular digestion, complete the nutritive process, whose finely ground and digested elements are carried to the most distant parts of the bell-like body.

Truly the enemies of young fish are legion in the surface waters of the sea, but Nature has made ample compensation by rendering our most valuable food fishes the most wondrously prolific of all vertebrates.

DISCUSSION.

PRESIDENT: This is a world of tooth and fang and sharp claw, where things eat and get eaten. Professor Prince has presented this subject in a striking way and it will suggest to us all that the importance of these lower organisms in fish life may be much greater than we have hitherto supposed. Enormous numbers of fish eggs do certainly disappear somewhere, for some of these fishes produce them by the million. In a few cases, I have been able to observe their seizure by small organisms, but the evidence is difficult to obtain, and proofs of such seizure are rare.

DR. HUNTSMAN, of Ontario: A year ago I started to study wall-eyed pike, keeping them in quantity, and they began to eat one another. In all cases the captured fish was taken tail first and the captor swam about with the head of his prey protruding. One fish was captured at our biological station with three heads protruding from its mouth. With the perch, too, it was found that specimens from four to six inches long had often swallowed others of the same species and in

all cases these were taken tail first. Notice this reversal of the usual method.

PROFESSOR WARD: In connection with this question it seems rather odd that such a slow creature as the jellyfish should be able to capture a fish by approaching it from behind. I should think it doubtful that it could do so under ordinary conditions, though it might if the fish were weakened. Professor Prince has alluded to the fact that fishes have been seen sheltered by jelly-fishes. Here on the northern coast the jellyfish (*Aurelia*) seem almost constantly to have young haddock associated with them. I think these fishes were truly sheltered and in no danger of being eaten. Jellyfishes also furnish food for fishes.

POSSIBILITIES OF AN ACRE FISH POND

BY PROF. L. L. DYCHE, *State Fish and Game Warden, Pratt, Kansas.*

Three years ago an acre pond at the Kansas State Fish Hatchery was stocked with several kinds of fish. The exact size of this pond, which was No. 4 in the old series, was one and sixteen one-hundredths (1.16) of an acre when the pond was at standard height, but as the water usually stood a little below standard, the pond was almost an exact acre in size. After the pond was stocked, but little attention or care was given to it for a period of three years. The pond was stocked as an experiment and with the hope of raising some good brood stock fish that could be used in the future to stock a proposed new fish hatchery. The pond is nearly circular; however, shape makes but little difference. At the edge of the pond the water is shallow, but the ground or bottom surface in a general way is basin shaped and gradually slopes to the deepest place, which is about thirty feet from the east shore line. At the bottom of this deepest place or kettle there is a drain pipe which is used when it is desirable or necessary to lower the water or drain the pond. When the pond is full of water or at standard height, it is six feet deep in the deepest place. This pond has a soft mud bottom, except for a few spots where the ground is rather hard and covered with a little sand and gravel. The water is carried into the pond through two three-inch pipes that connect with other ponds. However, just enough water was allowed to run into the pond to keep it at a certain height. Usually, the water stood about five feet deep in the kettle in the summer time and six feet in the winter time, the idea being to keep the pond supplied with water, but not to have any overflow or waste. There are many ponds in the country that are fed from wind mill pumps, or from springs or small streams. Under such conditions there is little or no water to spare. When there is an extra supply it is usually needed, either for stock or for small garden irrigation, or for both purposes.

VEGETATION IN AND AROUND THE PONDS.

This acre pond had in previous years been thoroughly stocked with water plants, including various kinds of so-called "mosses," especially *Chara* and one kind of lily (*Castalia odorata*). There are several patches of these lilies and we estimated that about one-fifteenth of the surface of the lake was covered with lily pads. The north and east banks above the water line are covered with swamp grass, with a few rushes along the water line. Higher upon the bank small willows are growing and some of them hang over the water. A number of large cottonwood trees stand on the south and west shores of the pond. They furnish some shade, but we do not consider them of any particular value in connection with fish production. There are other ponds that do quite as well and even better, that have no trees around them. We do not advise having trees right up against a pond. A grove of trees should be a little distance from a pond so as to reduce the number of leaves that would fall and blow into the water. The leaves are of no value to the fish and frequently color the water and in some instances have been known to damage the water, when the pond was low, to the extent that it rendered it unfit for fish to live in.

STOCKING THE POND.

Three years ago in the spring of 1910, this pond was stocked with about 10,000 yearling fish, most of which had been raised in it. All of the larger fish were removed, together with 20,000 yearlings. The fish that were allowed to remain were black bass, crappie, blue-gill sunfish, common green sunfish, bull-head catfish, a few hickory shad and German carp and about 300 goldfish. Many of them were small and only fit for food for the larger bass. In the fall of 1910, a few months after the above stocking, about a thousand more small fish of various kinds were added to this stock, including 200 black bass that were from four to six inches long. These bass had been hatched in the spring and were unusually large and fine

for their age. They were cannibals and we placed them in this pond because we had no other convenient place for them. We usually distribute such fish as soon as possible after getting hold of them, in the larger creeks and rivers.

In the spring of 1911 about 1500 two-year-old crappie were added to the stock of this pond. These were a fine lot of fish and many of them had spawn in them. However, they were the same size and age as the yearling crappie that had been left in the pond in 1910. At this time 2,000 bullhead catfish, one and two years of age were added to the stock; also 192 channel catfish that would weigh from one to two pounds each. The channel catfish were placed in the pond by mistake, due to a misunderstanding of orders. About one-half of them were caught at the feeding station and removed during the summer and fall of 1912.* During the spring of 1912 about a thousand more one and two-year-old fish, a miscellaneous lot, were placed in this pond. They were mostly small fish that we had no particular place or use for. They were thrown into Pond No. 4, as it was called, with the idea that they might, for the most part, serve as food for the other fish. Altogether about 16,000 fish were placed in the pond; however, many of them were only considered as food fish for the others.

FOOD FOR THE FISH PRODUCED IN THE POND.

Around the shores of this pond during the spring and summer of the year 1912 and 1913 there were thousands and thousands of young fish to be seen, frequently appearing in clouds or bunches several feet long. Among these young fish we noticed bass, blue gills, sunfish, carp, goldfish, shad and bullheads. It was very apparent that many of the fish in the pond had spawned and that great numbers of the eggs had hatched. This crop of

*They did not breed in the pond, at least no young fish were found. We considered it a misfortune to have them in with the other fish which they continually fed upon.

young fish served for the most part as food for the older and larger fishes.

This pond, from the time it was first stocked, was allowed to stand practically undisturbed. Most of the food supply for the fish was produced in the pond. The dense growth of vegetation was not disturbed except that boats were sometimes run through it to open up channels of water. The chara "moss," lilies and other water plants grew to the extent that the surface of the water during part of the summer months was almost a solid mass of vegetable matter. This growth of vegetation so completly covered the surface of the pond that at times only small patches or lanes of water could be seen. On two or three occasions during the hottest part of the summer, the water went down until the deepest basin was not over four or four and one-half feet in depth. This was due to growths of vegetable matter that partly stopped up the water pipes. The pipes were opened as soon as it was discovered that the water was going down in the pond.

TEMPERATURE OF WATER.

The temperature of the surface water during the month of August, taken at 8 A. M. and 5 P. M., varied from 70 to 91 degrees Fahrenheit, the usual temperature varying somewhere between 80 and 86. The temperature taken at the bottom of the pond was from one to three degrees lower than at the surface, but never as much as four degrees. The temperature of the air for the same month taken in the shade at 8 A. M. and 5 P. M. ranged from 70 to 95 degrees Fahr., but on a few occasions was over a hundred at some intervening time during the day.

HOW THE FISH WERE FED.

The fish in this pond, when fed, were given liver, chopped up fish, corn chop and some small quantities of other kinds of food. They were fed from a platform that was built about fourteen feet from the east shore and near the deepest basin in the pond. A boardwalk led from

this platform to the shore. On the platform there was a chopping block and during the summer of 1911 and 1912 about five hundred pounds of liver and five or six hundred pounds of fish, mostly German carp, were chopped up and fed to the fishes. When the chopping began, the fish would appear, the bass first and then the channel catfish. The bass would take the first food that was thrown on the water. It was necessary to satisfy them before any of the other fish would have a chance to get any food. The channel catfish would feed next. The blue-gills and green sunfish would feed around the edge of the general mass of fish, grabbing and darting away with anything they could get. The bullheads would come last and stay longest and would take food from the surface of the water. No crappie were ever seen to come near the feeding station. If they fed at all it was so deep under the water they could not be seen. About 200 pounds of corn chop were thrown in on the feeding grounds and perhaps as much as fifty pounds of kaffir corn. The catfish, carp and goldfish took most of this. However, the blue-gills and sunfish took some of it. When bread was thrown in the goldfish, carp, bullheads and blue-gills would take it.

REMOVING THE FISH FROM THE POND.

About the middle of April, 1913, we began lowering the water in this pond. From April 25, to April 30, the fish were removed and placed in other ponds. Most of the fish were used to stock the ponds of the new hatchery. After the water had been lowered the large fish were rounded up by the use of seines with meshes an inch square. Minnow seines were used to capture the small fish. The fish were removed from the water to the tubs and transfer tanks by the use of hand nets ranging in size from eight to twenty inches in diameter. A stream of fresh water was allowed to run through the pond until all the fish were removed. This prevented the water from getting so muddy that it would injure the fish.

FISH TAKEN FROM THE ACRE POND FROM APRIL 26 TO APRIL 30.

No. spec.	*Kind and size of fish*	*Lbs. each*	*Total lbs.*
280	black bass	large 2½	700.
310	black bass (1 and 2 years)	1	310.
95	channel catfish	large 4	380.
1,986	bullheads	" 1	1,986.
630	bullheads, yearlings & 2 yr. olds	" 8 to 1 lb.	79.
350	crappie, dark (calico bass)	" 1¾	612.50
500	crappie, one and two yrs.	not est.	
1,490	blue-gills	large ½	745.
1,100	blue-gills, two yrs.	" 6 to 1 lb.	183.
650	goldfish	" 1½	975.
	goldfish, young, very few		
27	carp	" 6	162.
	carp, young, very few		
103	hickory shad	" 1½	154.50
227	hickory shad (2 and 3 yrs.)	" ½	123.
700	green sunfish	" 3 to 1 lb.	233.
1,000	green sunfish	" 6 to 1 lb.	166.
5,000	green sunfish (1 and 2 yrs.)	not est.	
12,000	bass, crappie and blue gills, yearlings	not est.	
26,448	Total number of fish taken out of pond.		
	Total number of lbs. of fish taken out of pond		6,809.00

The above list is about as nearly correct as it could be made under the circumstances. We could not weigh all the fish, but fish of a certain size and length could be measured and weighed. There were two large-mouth black bass that were over twenty-two inches in length and each weighed a fraction over six pounds. They were females and heavy with spawn. There were many crappie that would weigh over two pounds, and bull-heads that weighed over two pounds. The carp would weigh from five to twelve pounds. There were many channel catfish that weighed from four to eight pounds.

There were 1,986 large bullheads but only a very few yearlings and two-year-olds, 630 all told. There were only 350 large crappie, though 1,500 fine two-year-old specimens were put in the pond in the spring of 1911. They were undoubtedly devoured by the larger bass and channel catfish. Only a few one and two-year-old specimens were found. There were 1,490 large blue-gills and only a few young fish; 650 large goldfish and almost no young; 27 large carp and less than 100 young fish. There

were more young of the green sunfish and blue-gills than of any other variety.

While the channel catfish were being handled in the transfer tanks, they would spit up fish that they had swallowed. Sunfish, blue-gills, crappie, goldfish and gizzard shad were most common among the ejected fish. They would range in size from one ounce to one-half pound each. The bull-heads spit up the same varieties of fish but, of course, the average size of specimens was smaller.

About 16,000 young fish were placed in the ponds (as counted). About 27,000 of all ages and sizes were taken out. Estimated weight of fish placed in pond not to exceed 700 lbs. Estimated weight of fish removed from pond was 6,809 pounds.

The total number of fish that weighed one pound each or over, was 3,801, and their total weight 5,280 lbs.

Black bass, crappie and catfish made up 3,988 pounds of this weight. If the weight of the blue-gills and green sunfish that were large enough to eat were added to the above, it would amount in all to over 5,000 (5,315) pounds of good table fish.

The carp, goldfish and gizzard shad weighed over 1,400 pounds.

The amount of food fed to the fish while they were in the pond can be summed up as follows:

500 lbs. chopped up liver and meat.
600 lbs. chopped up fish (mostly German carp).
200 lbs. corn chop.
50 lbs. Kaffir corn.
50 lbs. other kinds of food (bread, oatmeal, potatoes, etc.)

It might be well to note that about five bushels of tadpoles of the bullfrog were thrown into this pond after it had been stocked. Crayfish were common in this and adjacent ponds.

DISCUSSION

PRESIDENT: I hope that the Society is properly impressed with this paper. It is an amazing record. I have never heard anything like it and I strongly suspect that Prof. Dyche has put most of us to a standstill in the matter of pond fish culture. Prof. Dyche's experiments show that there is an enormous increment and that the fish food supply can be greatly increased by pond culture.

MR. BOWER, of Michigan: I agree with the President that this surpasses any record of which I have any knowledge. We are carrying on similar experiments, but have never begun to equal it. I think it is due very largely to the high temperature of the water and the production of an immense amount of natural food. In our latitude we could hardly have the same conditions and our ponds, if they ever get as warm would not remain so for many days in the year. It shows what might be done and that we might very profitably engage in such culture, but whether it could be made more profitable than land culture I do not know.

MR. LYDELL, of Wisconsin: We have a pond similar to the one Prof. Dyche has described, and for the last two years we have been dumping into it almost everything with the idea of rearing our own stock fish instead of collecting them in other waters. So far we have been very successful, but nothing to compare with Prof. Dyche's experiment. This pond is about 72 degrees, at the warmest, so that we could not get the same growth in the same length of time as he would get in a warmer pond. We are hoping to build a larger pond with a view of raising our breeding stock instead of collecting it.

DR. GEO. W. FIELD, of Massachusetts: May I call particular attention to the fact that this is one of the best and one of the first instances, perhaps, of definite information as to the quantity of fish that can be raised in a given amount of water. Also there is the question of handling this pond on the principle of the aquarium, with the specific data of how much food a certain quantity of fish require. The application of this is very important. As the country becomes more settled, it is absolutely necessary to furnish the people with pure drinking water. If, on the one hand, carnivorous fish are allowed to grow in reservations of drinking water, judging from observations we have made, you will get a small number of large fish, and the algae which cause the poisonous odors and taste in drinking water will multiply unduly. On the other hand, if the right proportion of carp fish are kept you will have the best conditions to secure the best quality of water. We need specific data on ponds, and Prof. Dyche's work will help very much toward the solution of the problem.

MR. TITCOMB, of Vermont: In our part of the country it would be impossible to do anything of this sort. The colder the water, the less the number of fish. A great many deductions can be drawn from these data and I want to inquire of Prof. Dyche whether, if he were to conduct the experiment again, he would put in as many fish as he did in this case? I believe he acknowledges he would not put the catfish in.

PROF. DYCHE: I am in doubt. I would not leave out the hickory shad or the goldfish, for I prefer these for food fish. I am not sure about the carp, they grow pretty large, and the young carp grow faster than the goldfish. I would leave out the carp and the channel catfish, but nothing else. I do not say that you would have to have goldfish and hickory shad, but there should be fish enough of some kind to consume a large amount of waste and convert it into food for the young bass, blue-gills and crappies. The blue-gill is one of the best fish we have for food for the bass. We are raising tens of thousands of blue-gills and goldfish. The blue-gill spawns about a month later than the bass and on examining young bass in the fall we find they have been feeding on the blue-gills. If they do not have these or some other fish to feed on they will eat each other.

MR. TITCOMB: You have considerable algae?

PROF. DYCHE: Yes. At certain times in the spring the spirogyra is abundant. The goldfish feed on it. Duckweed comes in immense quantities, and the goldfish feed extensively upon it. We have 20,000

yearling goldfish in one pond now and it takes 20 to 30 pounds of duckweed per day to feed them. The goldfish are to serve as food for spawning bass this winter. The more vegetation we have in the ponds, the more fish we get, other things being equal.

MR. TITCOMB: Does that restrict cannibalism, and do the fish get full size?

PROF. DYCHE: Yes and no. On the vegetation, in the warm water, at 84 to 88 degrees all summer long, are snails and other forms of animal life of various kinds. The little fish feed in this vegetation. The bass grow large and fine. We got fish out of the acre pond to stock nearly the whole series of ponds. This pond was a very great surprise to me and the men working on the hatchery, as well as to everyone else, because we got two or three times as many fish as we expected to get and we were expecting a good crop.

MR. TITCOMB: What was the average depth?

PROF. DYCHE: I cannot say. It is six feet in the deepest place in winter and five and a half in summer. Around the shore it is about fifteen inches deep and slopes down gradually.

MR. TITCOMB: Would you expect the individual who owned a fish tank to stock it in any such way? Would you recommend the same varieties?

PROF. DYCHE: I do not see why a great many farmers who own acre ponds should not have a supply of fish in the second or third year if they know how to take care of a pond and have plenty of vegetation in it. I generally give them goldfish as a food fish for other fish. They usually want black bass and nothing else. I give them what they ought to have rather than what they want.

MR. BOWER: What is the amount of infall in this pond and what is the amount of water in the spring?

PROF. DYCHE: There are two 4-inch iron pipes which convey the overflow from two other ponds to keep it at standard height. The pond was practically stagnant* as are most of the ponds in Kansas. Notwithstanding the fact that the carp and goldfish were in there the water was usually clear, except in spots 40 to 50 feet across where the water was sometimes roily.

MR. TITCOMB: Did you have crawfish?

PROF. DYCHE: We have them in all the ponds, but if they get too numerous we stock with black bass, which is the only cure I have for them.

PROF. REIGHARD, of Michigan: What were your expenses and have you figured the annual profit per acre, so as to compare it with what it is possible to make on an acre of land?

PROF. DYCHE: We were running the hatchery for the State and managed this pond in connection with others. No account was kept except of food that we fed the fish in the spring and during part of the summer when we thought food was needed. We never figured out the expense or profit in any way. Our main object was to see how many and what sized fish we could produce in a given length of time.

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*Meaning that there was no overflow, but the water was clear and good.

ONE YEAR'S WORK AT THE KANSAS STATE FISH HATCHERY

By Professor L. L. Dyche.
State Fish and Game Warden, Pratt, Kansas.

One year ago the pond system of the new Kansas State Fishery Hatchery was being built. The earth embankments were all completed in the rough by the middle of October. The entire system of over 80 new ponds with their cement water transmitters fitted with gates was ready to be tested at this time. Exercises appropriate for the occasion were held in the presence of about five thousand visitors.

WATER TURNED IN.

The gates were opened on the 29th of October and the water turned into the 21-inch supply pipe at 10 o'clock A. M. Only about half a head of water was turned on, but it reached the receiving pond that borders the west end of the hatchery in less than thirty minutes. One-half hour later a full head of water was running and it flowed into the hatchery from a receiving chamber over an iron weir plate, in a stream five feet wide and about six inches deep, delivering over 125,000 gallons per hour or about three and one-half million gallons per day. The ponds to be filled were all new and had never had any water in them, except a small amount from local rains. It was estimated that it would take about sixty days to fill these ponds as the banks were new and it was thought that the seepage would be very great. The ponds were all filled, that is, to standard height, which means six feet of water in the deepest place, in a period of less than forty days.

GOPHER BURROWS UNDER EMBANKMENT.

It was soon discovered, however, that in places the seepage was great and that there were many leaks due to the fact that there were a great many gopher tunnels that led from one pond to another and through the outside embankments. Gophers were very common in the

ground on which the hatchery was built; it was an alfalfa field before it was converted into fish ponds. The ground was plowed a foot deep but this did not destroy the gopher burrows as many of them were found to be from sixteen to eighteen inches below the surface. The gophers had also made some holes in the new embankments. It became necessary to drain the ponds and to fill them, one, two or three at a time. Digging into the banks and stopping the gopher holes proved more of a task than was expected. After the burrows were located and the banks properly dug away, the holes were stopped by pushing burlap into them, then tramping with dry dirt and finally placing a sack of earth over the hole. It took much time and labor to dig and find the burrows and their many ramifications and to follow them up to places where they could be successfully fixed. It frequently happened that there were tunnels that crossed and connected with other tunnels that led from one pond to another. This made it necessary to do a great deal of digging before the leaks could all be plugged. Only about twenty ponds were fixed before it was necessary to turn the water into the entire system. The gopher burrows caused no end of trouble in the ponds where they were not repaired. We hope to have them all repaired before it is time to stock the ponds next spring. If we ever build another system of ponds, we will surely see to it that the gopher burrows are plowed or dug up before any embankments are constructed.

WAVES CUT NEW BANKS.

The banks were soft and the March winds caused the waves to cut them badly in places. However, this action of the wind and waves was anticipated and was provided for by having the embankments built plenty wide and about two feet higher in most places than they were to be when finally finished.

The water was allowed to flow into the ponds until it stood from twelve to twenty-four inches above normal or standard height. The March winds caused the waves to

lash the banks continually and washed some of them to their tops and did a good deal of cutting into their sides. Early in April the water was lowered from a foot to eighteen inches and it was found that the waves had washed the dirt from the banks so as to make a fine natural beach around each pond; it was also found that there was plenty of earth remaining to finish the embankments and make good roads over them anywhere throughout the pond system.

PROTECTING THE NEW BANKS.

Experience had taught us that banks protected with a growth of swamp grass withstood the action of the water best. It so happened that there were a few acres of swamp grass on the hatchery grounds. Swamp grass sod was turned up with a sod plow in strips sixteen inches wide and cut in pieces from sixteen to twenty inches in length. When the water in the ponds was at normal height the sods were laid and tramped into the mud just above the water line. This made a band or border of sod sixteen inches wide around each pond. It took about twelve miles of this sod band to encircle all the ponds and, like fixing the gopher holes, used up much time and labor. During the summer the grass has grown in many places as much as two feet in height and has begun to spread some. By next spring we think that the banks will be fairly well protected. In other ponds where the grass was planted three years ago, it has grown to three or four feet in height, and is a fine protection to the banks and incidentally to the schools of young fish that feed near the water's edge. Waves do not seem to make any headway cutting the banks where this grass has a good start. However, this variety of grass does not grow well on pond banks in a dry climate except for a distance of about two feet above the water line. Thus far, we have not found a good grass for the top of the embankment. Bermuda grass answers the purpose, but it winter kills in our climate. The natural grasses that grow on the banks are fox tail and sandbur grass,

both are extremely hardy but neither is very desirable. Among other things we expect to try white clover which has been found growing in a few places on the banks of the old hatchery.

FINISHING THE EMBANKMENT.

After the waterline of the embankments had been sodded with swamp grass, the work of putting the embankment in good shape was begun. Plows, harrows and king drags were used. The embankments were crowned or rounded from one water's edge to the other, but made flat enough on top for good roads. We do not care to have the embankments more than two or three feet higher than the standard water height of the ponds, the lower the better, so that good driveways can be maintained between the ponds.

THE WATER SYSTEM.

Water for the hatchery is received in Pond No. 1 through a twenty-one-inch pipe which carries it from a receiving pond 1 1-3 miles to the west. Pond No. 1 is a long pond and extends north and south across the west end of the hatchery. From Pond No. 1 water is distributed to five chains of ponds that parallel each other and stretch for a mile to the east. There are from sixteen to twenty-one ponds in each chain. Each string of ponds is connected with Pond No. 1 by a ten-inch pipe. If it is desired to drain Pond No. 1, the five gates controlling the five ten-inch pipes are closed. By placing two or three eight-inch flashboards over the iron weir the water from the twenty-one-inch pipe can be turned into the second part of the receiving chamber which is just back of the first part and separated from it by a cement partition. From this second chamber there are also five ten-inch pipes that carry the water under Pond No. 1 and connect with the five chains of ponds. This makes it possible to stop the flow of water into Pond No. 1 when it is necessary to drain it and at the same time keep it running

through the five chains of ponds that make up the main body of the hatchery.

In other words, there are, all told, ten ten-inch pipes that carry water from Pond No. 1 to the five chains of ponds that make up the pond system of the hatchery. Nearly all ponds in the five chains of ponds are connected with adjacent ponds by two ten-inch pipes and each pond in a chain that extends east is from six to twelve inches lower than the one west of it. This gives a good gravity flow to the water through the system.

The gates that control the water in the pipes and the wire screen gates that control the fish, are all set in solid cement structures called water transmitters. The new water system seems to work well, though in places the new earth that was not yet compact and had no vegetation to help hold it, washed down and somewhat interfered with the wire screen gates in the cement water transmitters. Where the ground was compact, but little trouble was experienced, and after another year or two, when the ground has settled and is covered with vegetation we expect but little, if any, trouble. It will be two or three years before these ponds and embankments can be put in good shape. It takes time for banks to settle and for vegetation to get well set.

STOCKING THE NEW HATCHERY.

As spring began to advance, many plans were made for stocking the new fish hatchery. The ponds were new and without any vegetation. About one-third or one-half as many spawners were placed in each pond as would have been placed in them if they had been well supplied with vegetation. The ponds were stocked in the last part of April and the first part of May. In less than a month after black bass were placed in them, schools of young fish were seen near the shore. Schools of young crappie were seen in June, bull-heads and blue-gills appeared in the latter part of July and the first part of August.

NATURAL SUPPLY OF PLANT LIFE.

The supply of water for the hatchery comes from the Ninnescah River which is only a creek in size. This river is well supplied with vegetable matter. The water brought many forms of life, both animal and vegetable, into the ponds and it was soon observed that various kinds of water plants had started to grow along the shores. Several kinds of water plants, including "mosses"* and lilies, were planted in the ponds. All this vegetation has done well, and at the present time there is a very fair start of water plants in most of the ponds.

FISH IN NEW PONDS.

So far as we have been able to observe, the fish also have done well. Many schools of black-bass, crappie, blue-gills and bull-head catfish have been seen in the ponds. We estimated some of the bunches that were observed feeding along the shore in July and August at from five to twenty thousand young fish. These young fish have also made a fine growth. On August 23 young black-bass, from three to six inches in length, were seined from one of the new ponds. They were large enough to take full-sized grass-hoppers and to be caught on a hook baited with a grass-hopper.

NUMBER OF FISH AND WATER CONDITIONS.

Just how many fish we have, cannot, of course, be estimated with much certainty at the present time. However, we have reason to believe that if the fish could be moved early this fall, that there would be anywhere from fifty to one hundred car loads, estimating from five to ten thousand to the car load, depending on size and kind of fish. We had planned to begin the distribution of these fish about August 1st. However, water conditions in Kansas have been most unusual this summer. It is one of the dryest years, taking the entire state into consid-

*The chara, the water milfoil, and most water plants with finely divided leaves are usually, though incorrectly, called "moss."

eration, that has been experienced, perhaps the dryest, since the historic dry year of 1860. Many good Kansas streams are very low, and some of the smaller ones have dried up except for certain pools of water. The large rivers are very much below normal for this season of the year. Many of the ponds not well supplied with water have gone dry. The temperature during a part of July and the month of August surpassed the 100 mark nearly every day for many days in succession. Under such circumstances it has been necessary for us to hold the young fish. Every bass fish culturist knows what great losses occur when young black-bass are held in ponds where there is not a good growth of vegetation and where they cannot be sorted and specially cared for. It will not be possible to deliver fish until water conditions have improved. There will be a great demand for fish when the ponds and streams regain their normal supply of water.

FISH RAISED ON NATURAL FOOD.

The fish raised in the hatchery this season, raised themselves, so to speak. The spawners were simply placed in the ponds and allowed to remain there. They were given no food other than what they found in the water. The Department has been so busy with buildings, grounds and office business that the fish culture work seemed but a side issue. We hope to be able in the near future to give more attention to the fish business and make it the chief business of the Department.

However, we do not expect to feed fish at the hatchery except on a small scale and when experiments are being performed. We hope to so stock the ponds with plants, animals and fish that there will be a natural supply of food for both old and young fish. The fish that eat vegetable matter and waste, so to speak, such as carp, goldfish and hickory shad, will be made to supply food to a very large extent for the game fishes. In other words we desire to convert the natural plant and animal wastes of a pond into fish food and food for fish. To illustrate, both goldfish and hickory shad convert great quantities

of waste into a fish flesh that is fine food for other fishes. We hope to raise fish by utilizing the natural products that the water produces.

The owners of ponds and small lakes in our part of the country have little or no time to feed fish. The ponds should be stocked with the proper kinds of vegetation which in itself not only serves as food for many fish but produces the many forms of animal life that fish, especially small and young fish, live upon. We desire to especially mention the blue-gill sunfish as a general utility food fish for man and for fish. This fish spawns late in the season and is very productive in our ponds. The young blue-gills, which appear in great numbers in the latter part of July and in August, make a fine fall and spring food for the young bass and crappie. The blue-gill itself seems to be a rather omnivorous feeder, eating more or less vegetable matter and various forms of small animal life.

BUILDINGS.

On the 19th of September, a year ago, the contract was let for the building of "A Kansas State Fish and Game Building," a power house, five cottages for employees, a residence for the Warden, a barn, a workshop and fifteen tool houses. This group of buildings is just about completed and will furnish homes on the grounds for the permanent part of the working force of the hatchery. The Fish and Game Building is built of concrete and bricks with a green tile roof and is fire proof. The main part of the building is 70 by 52 feet with an addition 65 by 42 feet for an aquarium. On the second floor of this building, the Department will have its general offices. On the first floor will be found laboratories where various kinds of scientific work will be carried on in connection with the general work that is being done by the Department. There is a small aquarium consisting of a series of twelve tanks that hold on an average 540 gallons of water each. These will be used for carrying on experiments as well as for exhibition purposes.

HATCHERY GROUNDS FENCED.

The size and unprotected condition of the hatchery grounds made it possible for certain loose-jointed persons to enter upon the premises at night and commit various depredations. Parties were caught fishing in the ponds. At different times it was discovered that the water gates had been tampered with, either the water was cut off, turned into the drain pipes or wire screen gates were disarranged. After a conference with Governor Hodges, who personally investigated the matter with us, it was decided that it was necessary to fence all the hatchery grounds, about 200 acres, including the fifteen acres where the dam and intake are located.

The work of placing a stout two-inch diamond mesh steel "Elwood" fence around the hatchery grounds is nearing completion. We soon discovered that there was a good deal of work connected with the fence business, as it takes more than three miles of fence to enclose the grounds. This fence is being strung on iron posts. There are two barbed wires at the top, which makes the fence six feet high. All corners and gate posts as well as the braces have been set in solid blocks of concrete that are twenty inches square and extend into the ground for a distance of three feet. With this fence completed it ought to be possible either to keep marauders and meddlers off the grounds or to apprehend them before they can get away.

By another year we hope that the building work will be finished and that we will be in the fish business.

DISCUSSION

MR. NESLEY, of New York: I would like to inquire whether Professor Dyche raises the small-mouth or large-mouth black bass.

PROF. DYCHE: We raise only the large-mouth bass; the small-mouth bass has disappeared in competition with the large-mouthed when placed in certain Kansas waters.

MR. BOWER, of Michigan: Will Professor Dyche tell us what has been the expense?

PROF. DYCHE: I have not figured it out yet, but I think it is about $150,000, though it may be more than that. I am spending all the money I can get to develop the hatchery.

MR. WOODS, of Missouri: I wish to offer to Kansas, adjoining my own State, congratulations for its remarkable work along this line in which we are all interested.

THE PRIVATE FISH POND--A NEGLECTED RESOURCE

By C. H. Townsend, *Director of the New York Aquarium.*

The possibilities of small fish ponds as sources of food for the people have received little consideration in this country and the actual breeding and maturing of fishes in such ponds is an art which we have yet to put in practice. While certain foreign countries have long profited by the art of private fish culture, and have furnished notable examples, our own facilities for this industry have been neglected. It is probable that our resources in this respect are greater than those of other countries, as the United States already lays claim to the most extensive fish cultural operations carried on in the world, and nowhere is there so large a body of professional fish culturists as that connected with our national and state fishery commissions.

In these times when the value of running streams for water power is being widely considered, the possessors of brooks, springs and small lakes should be awakened to the value of their home resources for water farming. At a former meeting of this Society I had the privilege of describing at considerable length approved methods for the construction and care of small fish ponds.* The matter is recorded in the printed transactions of the Society, and it is unnecessary, at the present time, to reconsider the methods of pond management, but it is always desirable to keep the subject of private fish culture before the public.

It is gratifying to note that trout culture, in the hands of the private citizen, is making some progress in Massachusetts and adjacent states, and the advertisements of successful trout raisers may today be found in American journals devoted to fish and game. Trout culture is,

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*Transactions of the American Fisheries Society, 1907. "The Cultivation of Fishes in Small Ponds," by C. H. Townsend, pp. 128-139.

however, a branch of the work which requires special conditions, such as purity of water, comparatively low temperature, the construction of buildings and artificial fertilization. The possibilities for the private or commercial culture of many other kinds of fishes, which are more widely distributed than the trouts and can be cultivated by simpler methods, should receive serious consideration. North America is abundantly supplied with hardy fishes which are available for this purpose. There are no serious difficulties in the way of obtaining them for breeding, and under cultivation they would yield a food supply which would supplement to an important degree that derived from the public fisheries.

In Europe the cultivation of carp is carried on extensively. This fish is now abundant in American waters and, while not comparable with many of our native species, already contributes annually many millions of pounds to our market supply. Despised by many, it is nevertheless marketed more profitably each year in most of our large cities and there is now no doubt that the carp is destined to supply a considerable amount of our fish food. The methods of carp culture, as practiced in Europe have been frequently published in this country and are available for use. It is unquestionably the easiest of all fishes to raise, and it is only necessary to turn to the weekly New York market reports for assurance as to its money value and extensive use. But it is our native fishes which I wish to consider especially in this connection, as many of them have been proved available for cultivation and are more acceptable as food to our people than the carp. Among them may be mentioned the various species of basses, perches, sunfishes and catfishes, which are well distributed in our eastern states, and there are other species inhabiting our western and southern states which are also available for pond culture.

My connection with a public aquarium has brought me into correspondence with many persons who have desired to undertake the raising of fishes, but whose efforts have been limited to the mere stocking of natural ponds. Com-

paratively few have realized the necessity of proper equipment and actual cultivation, which involve the complete control of the waters and of the fishes contained therein. Very little can be accomplished with a single natural pond; it is necessary to have several artificial ponds which can be readily controlled, while the various operations of pond culture require frequent attention and considerable actual labor.

The requirements for the successful management of several kinds of pond fishes have already been worked out at public fish hatcheries and there is more or less official information on the subject. It is not necessary at present to give instances where success has been achieved; my object, as already stated, is to keep before the public the fact that success in private fish culture is possible and that considerable fish food may be produced with the same amount of labor and intelligent effort that is necessary for the raising of fowls. There has been much agitation over the high cost of living, and it is time to consider what the individual citizen can do in the way of assisting in the production of fish food.

In some of the countries of central Europe the cultivation of fishes in private waters has been going on for centuries. In Austria and Germany fish farming, as it is often called, is a common industry. While it is much practiced by small land owners, there are many large estates which maintain hundreds of ponds in active cultivation. Much of this private fish culture is based on the various forms of the carp, but other European fishes are also cultivated for sale, such as the tench, ide, rudd, bream, perch and pike. Some European fish culturists are now raising American basses and perches. There are many villages in Austria where fish ponds are maintained at the expense of the community. In view of these facts, it is remarkable that immigrants from Europe have neglected to practice their ancient art of pond culture in this country.

Aside from commercial trout raising, which is practiced to a limited extent, we have nothing of such pond

culture in America. Our numerous fish hatcheries maintained under the direction of state commissions are devoted almost entirely to the stocking of public waters with young fishes. Very little of the product is reared to maturity and none of it is sent to market direct. If our fish culturists could be commanded to bring their annual yield of fry to maturity and deliver it to the market, they would be at a loss how to proceed. We are really not fish raisers, but producers of fry. At that stage our efforts cease. The rest is left to nature, and negligently cast into waters that we imperfectly protect and utterly neglect to keep pure. While our achievements in public fish hatching are notable, private fish culture has made no headway. A few of our state fish commissioners are making efforts in pond culture for the benefit of farming communities, notably in Kansas, and it will be interesting to observe what progress can be made. Perhaps the vast natural yield from our coast, lake and river fisheries is responsible for the lack of private effort.

Our fish supply, in general, is large and well distributed, but we could consume a much greater supply, especially in view of the fact that in some sections the natural supply is being depleted by over fishing and pollution of waters. There are many sections of the country inadequately supplied with fish food which could be produced locally by pond cultivation and such supplies would find convenient home markets.

It is possible for the private citizen to obtain pond fishes for breeding purposes, but he needs assistance and direction. Object lessons on approved methods of fish culture could be obtained by visiting public hatcheries, but this is not likely to be undertaken. It would be advantageous to the country if state fish commissions generally could supply the coarser fishes for cultivation in private waters and furnish the public free information as to the methods to be followed.

We should not rest content with the mere fact that such information exists in public documents. The editions of state documents are neither large nor well dis-

tributed, and rural populations may remain unaware that useful fishery information may be had for the asking. State fish commissions should not only prepare inexpensive pamphlets on the cultivation of common fishes, but see that they reach many communities and be announced and reviewed by the rural press everywhere. Model ponds distributed about the state for demonstrative work would, of course, be educational, like agricultural colleges and state experiment farms. I am not prepared to set forth the best means of doing this work, perhaps no two states would undertake it the same way.

I am convinced that some of the energy put into the production of fry is misdirected. The output is amazing; six billions last year by the National Bureau and perhaps as much more by the states. Practically all of it is hurried into the nearest river and none of it raised. We are all doing about the same thing and have settled into the rut of fish hatching in hatchery buildings. No one is doing anything new except as connected with the competition for increased output.

Having practiced these wholesale methods for two or three decades, let us now consider whether we might not profit by a little less fish hatching and a little more fish raising. Does salvation lie only in a multiplicity of expensive federal and state hatcheries? If our fishery establishments were equipped to raise and market one per cent. of the fry now being hatched and liberated, might not the quantity of food thus produced exceed that which eventually reaches market by way of the public waters? Let us simplify our art and teach it to the people, for they can surely help in the production of fish food.

DISCUSSION

PROFESSOR WARD (in the chair): The place which the Society has accorded this paper is sufficient evidence of its value. To open the discussion I will call upon Mr. E. S. Casselman, who, I understand, has had a very large experience in the building of such ponds for a private fish supply.

MR. CASSELMAN, of New York: My experience has been with large ponds, 75 to 200 acres in extent. We have used small ponds merely to provide food.

MR. NESLEY, of New York: I am engaged in private fish culture work, developing property in Columbia County, New York, belonging to a man from New York City. There is a lake with a circumference of six or seven miles, and running down to fifteen feet in depth. We will put in about twenty ponds this fall. We expect to specialize in the production of small-mouth black bass and perch in a commercial way. Perhaps in another year I may be able to report upon the results of our work.

MR. TITCOMB, of Vermont: In our State the man who has an artificial pond is not subject to the closed season covering public waters, and he can take his fish at any time of the year, just as he can take his poultry. I think it should be so in every state. This does not interfere with the enforcement of laws for the protection of fish in public waters.

PROF. DYCHE, of Kansas: Dr. Townsend's paper has interested me greatly and has suggested a number of things for me to do. In building fish hatcheries and in carrying out certain experiments I have followed up suggestions given in some of Dr. Townsend's former papers, and I propose to continue further experiments in line with some of his suggestions made here today.

NOTES ON STRIPED BASS

By J. P. Snyder.

As Mr. S. G. Worth in his reports to the Bureau of Fisheries and to this society in years past has fully covered the method of handling striped bass there remains but little for me to tell.

This fish, as is well known, leaves the sea and ascends our coast rivers each spring to deposit their eggs. Those entering the Roanoke River collect on the sand and gravel bars below the rapids at Weldon, N. C. Here they assemble in large numbers, moving but little until the water temperature reaches 67 or 68 degrees Fahr. Then they become active, ripen quickly and immediately begin spawning. If the water is clear enough for the males to find the females there will usually be a dozen or more around each female when in the act of spawning, for at such times, almost invariably, a number of male fish, perhaps a dozen or more, are taken in the same lift with a female. This is the exception when the water is muddy. In spawning the female seeks the sand beds where she frequently comes to the surface and vigorously lashes the water with her tail.

The fishing is done with bow nets which are very similar to landing nets, only larger, being about seven feet in diameter and having a handle about twelve or fifteen feet long. Formerly all the fishing was done from dugouts, but in recent years gas boats have replaced them to some extent.

Previous to the spawning season the Bureau of Fisheries establishes numerous depots along this part of the river where pans, buckets and dippers are stored for the use of fishermen in taking and caring for the eggs until they are delivered at the Bureau's hatchery near Weldon. Formerly spawn-takers were employed to take the eggs, but recently all the eggs have been taken by the fishermen. When a female fish is caught she is immediately examined, and if ripe, the men hurry to the nearest depot. While still alive the abdomen of the fish is ripped

open and the ovaries carefully removed. The membrane surrounding the eggs is then cut and all the loose ova are poured into a pan. When a large fish is taken more than one pan may be needed to hold the eggs. Live male fish are taken and their milt is ejected over the eggs. As the fish die quickly and the eggs and milt die with the fish the men must usually act hurriedly. Unlike the shad and some other fishes the eggs from a dead striped bass cannot be fertilized, even though the fish has been dead but a few moments. As soon as the eggs and milt are in the pan a little water is added and the pans are then tilted until the milt is thoroughly incorporated with the eggs. When first taken the eggs are very small, but they rapidly expand to many times their former size. During this time they must be thinned up and given more and more water and the pans must be agitated frequently or many eggs will not expand fully and soon die. When fully expanded they are put into buckets and taken to the hatchery or they may be taken in the pans while expanding and may even be placed in the jars with good results before expansion is completed, but when unexpanded eggs crowded in buckets are invariably lost.

In the hatchery they are placed in the McDonald jar having the brass top and glass and rubber intake tubes just as in shad work, but in this case the nickeled rim holding the brass top in place has a pitcher lip and no discharge tube is used. The water falls directly from the pitcher lip into the aquarium. Usually this fall is but two or three inches but experiments with greater amount of fall revealed no bad effects. In this my experience has been different from that reported by Mr. Worth.

The eggs are semi-buoyant, more so than those of the shad and whitefish and are nearly transparent. During incubation the egg or rather the vital part of it occupies but a small part of the space within the egg membrane. As it is heavier than water and light green in color the vitellus is easily seen lying on the lower inner part of the egg membrane and it keeps to this position as the egg circulates in the jar. Incubation is

completed in from thirty-six to forty-eight hours depending upon the temperature of the water. At first the fish are very weak and lie on the bottom of the aquarium but every few moments they struggle upwards for an inch or two then drop head first to the bottom. Gaining strength, they rise higher and higher, and in twenty-four hours all have left the bottom and swim about in the aquarium. The shells of the eggs are very light and it is impracticable to keep them from leaving the jars and passing into the aquaria. Here they collect on the bottom of the aquaria, and, in this warm water, soon decay and seem to poison the water, for, if the little fish are left in the aquaria with the shells, nearly all of them will die before they are two days old. To avoid this, as soon as the fish swim up well they are carefully transferred to clean aquaria, and in this case there is practically no loss unless they are weakened by lack of food when held too long. Those that cannot be transferred to a clean aquarium without taking up egg shells are taken out and planted.

As all the eggs are taken by fishermen, often under adverse conditions, and as special care is required in caring for them in the field, it is not surprising that a larger percentage of the eggs received fail to produce fish. This is especially true when it is understood that on an average a given fisherman does not capture more than one spawning fish in two or three years, and that it is only five years since the fishermen began taking the eggs themselves. Yet, during this time the percentage hatched has arisen from less than fifty per cent. to seventy per cent., so that, although we did not receive quite as many eggs last spring as on two previous years, we hatched more fish than ever before. To illustrate how little opportunity one has to experiment and study the handling and care of these eggs in the field I may say that during the past four seasons I have spent many days and nights on the river with the fishermen and have taken the eggs from only five fish, which were all the ripe fish I saw

caught. In closing I want to ask this question: "Has it been proven that these fish will not ripen in crates?"

DISCUSSION

PRESIDENT: The members present may remember that the striped bass was introduced on the Pacific coast twenty-five or thirty years ago, and has been one of the notable successes in the transplanting of market fish. They are perhaps more abundant on the Pacific Coast to-day than on the Atlantic. The shad is another unusual example of the same thing.

MR. BOWER, of Michigan: Were the shad and striped bass taken to the Pacific Coast as fry or eggs?

PRESIDENT: My impression is that the hatching was going on en-route and that they were practically all hatched by the time the Sacramento River was reached, and that they were planted as very young fry.

Note: As late as 1876, shad fry were taken from Holyoke, Mass., to the Sacramento River and deposited alive at Tehama, Cal.

T. H. BEAN.

IMPROVEMENT OF FISHING THROUGH A KNOWLEDGE OF THE BREEDING HABITS OF FISHES

By Prof. Jacob Reighard, *University of Michigan.*

When the breeding season approaches most fishes leave their usual haunts and travel a longer or shorter distance to their breeding grounds. The distance travelled may be a few rods, as in the common sunfish, or it may be hundreds of miles, as in the salmon. In any case it brings the fish into new surroundings. Here it seeks certain definite conditions which vary with the species. Some of the fish require swift water, others quiet water; some seek a bottom of sand or gravel free from vegetation; others seek a bottom on which there is vegetation, so that they may attach their eggs to its rootlets (which they expose in making their nests) or hang them in masses from its branches. Each chooses a breeding ground suited to it. Compared to the total area frequented by the fish of any water, the breeding grounds are of limited extent. It results that the fish are crowded together on the breeding grounds as well as in their approach to the grounds. This, in many cases, affords unusual opportunity for their capture. The whitefish is a notable instance of this.

The sexes are brought together on the breeding grounds. At the instant when the eggs are laid there is, in all known cases, intimate contact of the body of the female with the bodies of one or more males in such a way that the vents of the two sexes are brought together. When the eggs are expelled the water is at the same instant filled with a cloud of milt. Every egg is at once surrounded by hundreds, thousands, perhaps millions of sperms, each seeking to penetrate it. Under such circumstances fertilization is practically certain. It is a popular error, from which fish culturists are not altogether free, that a large percentage of eggs remain unfertilized in nature and that these consequently die. It is commonly held that by resorting to artificial fertilization

with its high percentage of impregnation, the fish culturist, by his method of fertilization alone, saves eggs that would otherwise perish. The fish culturist saves without a doubt, but not by his method of fertilization, for that is no more perfect than in nature. It is in truth, probably less perfect. In nature the eggs are laid only when thoroughly ripe and only in the presence of the fertilizing male. In spite of all his care the fish culturist, on the other hand, spawns females that are unripe and overripe and loses a considerable percentage in this way. He often finds eggs, naturally laid, a large percentage of which are dead, and may assume that these have not been fertilized. Under normal conditions the eggs that are unfertilized do not undergo cleavage and do not therefore form a blastoderm. If eggs are collected from natural waters shortly after they have been laid and while all of them are still living, it is found that practically all of them have undergone cleavage or that this has proceeded until a germinal disc has been formed. This in the early stages is the only criterion of fertilization. If the eggs are collected somewhat later many of them are dead and partly decayed and it is then impossible to tell whether or not they have been fertilized. To assume that they have not been fertilized is to ignore all that we know of eggs collected shortly after they have been naturally laid. I have collected from the natural waters the recently laid eggs of many fish and have failed to find any considerable number unfertilized. The gain of the fish culturist is therefore not in a higher percentage of fertilization, but rather in the protection afforded the eggs after fertilization.

The eggs may be laid in nests prepared by the male parent and are in that case protected by him until they hatch, or as in case of the black bass, until the young are well grown. Nearly one fifth of the species of fishes that occur in Michigan are known to build nests, and give their eggs, by this means, a protection analogous to that afforded by the fish-culturist. But the majority of fishes build no nests and their eggs suffer from many enemies.

The features of interest to us in our present discussion of the breeding habits of fishes may be summarized as follows:

1. At the breeding season fishes migrate from their ordinary haunts to the breeding grounds.
2. Each species selects a breeding ground characteristic of it. It shows a preference with respect to the character of the water (warmer or colder, clear or turbid, quiet or running), with respect to the nature of the bottom (sand, gravel, marl, muck, mud) and with respect to the presence or absence of plants.
3. Both sexes are present at the same time on the breeding ground. Their bodies are in intimate contact at the moment of laying of the eggs and practically all eggs are fertilized.
4. Some species construct nests for the protection of the eggs. Others construct nests and guard the eggs. Others continue the guardianship for a longer or shorter time after the eggs have hatched. Most species do not construct nests and do not guard the eggs or young.

In order that fishes may thrive in any natural water it is necessary that there be sufficient food and that there be available breeding grounds suited to each species. Most fishes are not *narrowly* limited in their choice of food. They are capable, with few exceptions, of utilizing the available animal food. Their choice of breeding grounds is more limited. Yet in attempting to determine the suitability of a particular water for a given fish, far more attention has been paid to food than to breeding grounds. Of the two factors the latter is probably the more important.

UTILIZATION OF OUR KNOWLEDGE OF THE BREEDING HABITS OF FISHES.

1. *Selection of Waters in Which to Plant Fish.* In the earlier days of fish culture in Michigan whitefish and wall-eyed pike were planted in many inland lakes. In a few of these the adult fish were afterward found, but in most of them the water remained as barren of the planted fish as before the planting. Conditions were evidently unsuitable, but in what respect? In most of the lakes thus planted it is probable that there was sufficient food for the adults of either of these species. But if suitable breeding grounds were lacking it is likely that conditions were in some way unsuited to the planted fry. In the case of the whitefish we have an imperfect knowl-

edge of what are appropriate breeding conditions; in the case of the wall-eyed pike we are, I believe, still quite ignorant. It seems to me useless to introduce the fry into waters in which suitable breeding conditions are not known to exist. We need more knowledge. In the absence of this, it is best to plant only in waters in which the fish are known to be already breeding, and to introduce the young, if possible, on the breeding grounds. Small-mouthed bass require clear water and gravel bottom for breeding. Large-mouthed bass prefer plant-grown bottom and are more tolerant of turbid water. Suckers require running water and gravel bottom. It is unwise to introduce any of these forms into waters lacking in the conditions peculiar to its breeding activities. What is true of these species is equally true of others.

2. *Preservation of Breeding Grounds.* The ditching of streams and the lowering of lake levels by this or other means need not seriously affect the food supply of many fishes whose breeding grounds it destroys. The common sucker, red-horse, the stone-roller and several species of valuable bait minnows lay their eggs or build their nests on the ripples of the smaller streams. Ditching such a stream destroys these breeding grounds. They may be restored by the meandering of the stream which forms new ripples by depositing in its bed materials eroded from its banks. But in the meantime the increase of suckers or bait minnows may have been seriously checked. If the stream is kept straight by repeated ditching these fish may disappear from it.

Where lake levels are lowered the breeding grounds of the majority of fishes may be destroyed. The pike lays its eggs in the marshes or on the shallowest weed-grown bottom, often on over-flowed meadows. The basses and sunfishes and the bullheads build their nests on the shoals in water usually not over two feet deep. The blunt-nosed minnow, food for the large-mouthed bass and pike, the Johnny-darter and the miller's thumb, lay their eggs under stones very near the shore. When the shoals are laid bare the breeding grounds of all these

forms are destroyed, or greatly limited. The new shore is usually of soft mud or marl without the stones needful for the small-mouthed bass and the smaller fishes mentioned above. From the shore the water deepens rapidly so that few shallows are left for any of the fishes. Lowering the lake level has thus destroyed or greatly limited both the food and the breeding grounds of the game fishes.

Raising of lake levels by damming their outlet may have a like effect by making the water over the shoals too deep for breeding fish. In this case new shoals are usually created by the overflow of flat lands and the fishes in time utilize these as breeding grounds.

It is evident that in all these cases the prolonged action of natural forces has brought the lakes and streams into such a condition that they afford to their native fishes both food and breeding grounds. The majority of fishes are more accurately adjusted to breeding conditions than to food. These conditions must be maintained or the fishes will greatly diminish or disappear.

3. *Protection of Breeding Grounds.* We are accustomed to protect fishes by forbidding fishing during the breeding season. The breeding season is not fixed by the calendar and may begin before the closed season or continue after it. The closed season is commonly too short to cover the breeding time, and the fishes suffer. In most waters there is always an open season for some fishes and the waters are never free from anglers, who are tempted to take whatever fish they can get, whether protected or not.

The breeding grounds, on the other hand, are of limited extent and may be definitely located by one who has knowledge of breeding habits. They may be marked by buoys and fishing on them prohibited while it is permitted elsewhere. For nest building fishes, like the basses, this method might prove more effective in preventing depletion than the present method of pond culture. It need not be more expensive. Under it fishing in a lake would be permitted during all seasons of the year, but

prohibited on the breeding grounds during a period long enough to adequately cover all fluctuations of the breeding season.

The presence of fishermen on the lake during the breeding season in greater numbers than under the existing system, should serve to protect the breeding grounds, for they would watch one another. Each would tend to see that others did not encroach on the prohibited areas.

4. *Construction of Breeding Grounds in Ponds That Lack Them.* Shelford (1911) has said that "the breeding interests and the feeding interests of still-water food and game fishes are distinctly antagonistic." As a pond grows older the amount of rooted vegetation in it increases until the whole pond bottom becomes thickly covered by it. The decay of such vegetation adds to the water chemical substances which serve as food for the microscopic plants or algae (Pond, 1905). The algae form the basic food for the microscopic animals. These in turn form the food of younger fishes and from them a chain of nutrient relations leads up to the adult fishes. Consequently as a pond grows older and the number of rooted plants in it is increased it contains more fish food. But this same process which increases the food supply of fishes, tends to destroy the conditions necessary for their breeding. The bottom becomes so thickly covered with muck that there are no bare sand or gravel areas remaining and these are necessary for some fishes. At the same time the decay of the organic matter, which falls to the bottom, may so use up the oxygen in the bottom waters that fish eggs cannot live in them.

If the above statement is correct then it follows that old ponds, which contain few or no fish, may again be made productive. They may be rich in the basic fish foods, but lack the necessary breeding grounds. By removing a part of the vegetation in water of suitable depth so that sand or gravel bottom is exposed in some places and a sparse growth of plants permitted in other places, suitable breeding conditions may be restored. By

the introduction of suitable fishes a barren pond thus treated might be made again productive.

I have attempted to show that through a knowledge of the breeding habits of fishes we may hope to preserve or increase our supply of fishes by one or more of the following means:

1. By wiser selection of the waters in which fish are to be planted.
2. By the preservation of existing breeding grounds.
3. By the prohibition of fishing on breeding grounds while permitting it in adjacent waters.
4. By the construction of breeding grounds in ponds from which they have disappeared through the operation of natural forces.

For the fisheries interests a knowledge of breeding habits appears to be more important than a knowledge of food habits. Yet our knowledge of breeding habits is still very meager. One of the purposes of the present paper is to stimulate an interest in them with the hope that thereby our knowledge may be increased.

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DISCUSSION

PROF. WARD, of Illinois: The substance of this paper must be very prominently in mind as it was continually emphasized in the paper by President Townsend and those of you who recall Prof. Dyche's paper of last year will remember that one of the very first things he considered in the construction of ponds was the maintenance of proper breeding areas for the fish. To have successful fish ponds we must take into account the habits of the animals to be kept in those ponds. I was asked some months ago to examine a pond installed by a southern Georgia fishing club, to tell them why they failed to get fish. The pond was just a receptacle containing a certain number of gallons of water, and without any shore area or plant growth whatever. The reason that fishes did not thrive was perfectly evident, but it had not occurred to the members of the club that the fish required any special place to breed. I am confident that many of the failures experienced in private culture are caused by lack of proper breeding places for the fish.

MR. NESLEY, of New York: While working on Lake Erie I found just the condition mentioned by Professor Ward. The southern side of Lake Erie has become so contaminated by the large cities that the majority of the whitefish spawn on the Canadian side. The State Department of Fisheries was compelled to go over on the Canadian side to collect eggs for the reason that the bottom there was not polluted.

A PLEA FOR THE PRESERVATION OF RECORDS CONCERNING FISH

By Jacob Reighard,
Professor of Zoology, University of Michigan.

For five years I have been in charge of the Biological Station of the University of Michigan, situated on Douglas Lake, about fifteen miles south of the Straits of Mackinaw in the Southern Peninsula of Michigan. During this time, more especially during the last year, I have recorded such facts as I could find out about the fish of the lake. In order to study the data collected I have arranged them in tables, one of which is reproduced below:

DATA CONCERNING PIKE (*ESOX LUCIUS*) OF DOUGLAS LAKE, 1911-1912.

Serial number	Weight ounces	Length inches	Sex	Water depth feet	Apparatus	Content of alimentary canal	Locality	Date
1	104	30.6		15	gill	2 four-inch perch	12	7,3,11.
2	28	15		25-30	gill	2 perch, 4½; 5⅜	5	7,11,11.
3	12	13.2	m	4	gill	fish, not determined	3	8,3,12.
4	15	15.4	f	12	gill	empty	3	8,8,12.
5	15	14.8	m	12	gill	fish	5	8,11,12.
6	16	15.2	m	12	gill	fish	5	8,12,12.
7	21	16.4	m	12	gill	empty	5	8.13,12.
8	30	18	f	26	gill	empty	4	8,15.12.
9	29.5	16.8	m	26	gill	empty	6	8,15,12.
10	26	17	m	26	gill	empty	6	8,15,12.
11	10	12.8	f	26	gill	empty	6	8,15,12.
12	10	12.8	f	26	gill	empty	6	8,16,12.
13	18	15.6	f	26	gill	empty	6	8,16,12.
14	24	17.6	f	26	gill	empty	6	8,20,12.
15	24	17.6	f	18	gill	2 fish	7	8,20,12.
16	29.5	17.2	f	18	gill	2 fish	7	8,20,12.
17	10	13.6	f	26	gill	empty	7	8,20,12.
18	10.5	13.6	m	25	gill	empty	7	8,20,12.
19	25	17.8	f	25	gill	empty	7	8,14,12.
20	27	18.8	m	12	gill	empty	5	8,14,12.
21	12	13.2	m	12	gill	empty	5	8,18,12.
22	59	19.6	m	45	gill	empty	6	8,18,12.

Lengths are measured from the tip of the snout along the side to the base of the rays of the tail fin.

By depth of water is meant the distance from the point at which the fish is taken to the surface, which is usually, although not always, the distance from the bottom to the surface. The localities may be indicated, as in the table, by means of numbers which refer to a map or by descriptive terms. It is convenient for purposes of discussion to indicate each fish by a serial number.

A number of interesting facts at once appear from the table. In July and August the pike in this lake are seen to range from a depth of four feet to that of forty-five feet. This depth-range at this season is explained by the fact that below forty-five feet the water contains little or no oxygen so that the pike cannot live there. At other seasons they may range deeper.

The food, so far as it may be learned from so few records, consists entirely of fish. The four fish well enough preserved for identification were perch. These were taken in spite of the spines of their dorsal fins, a hint perhaps to fishermen.

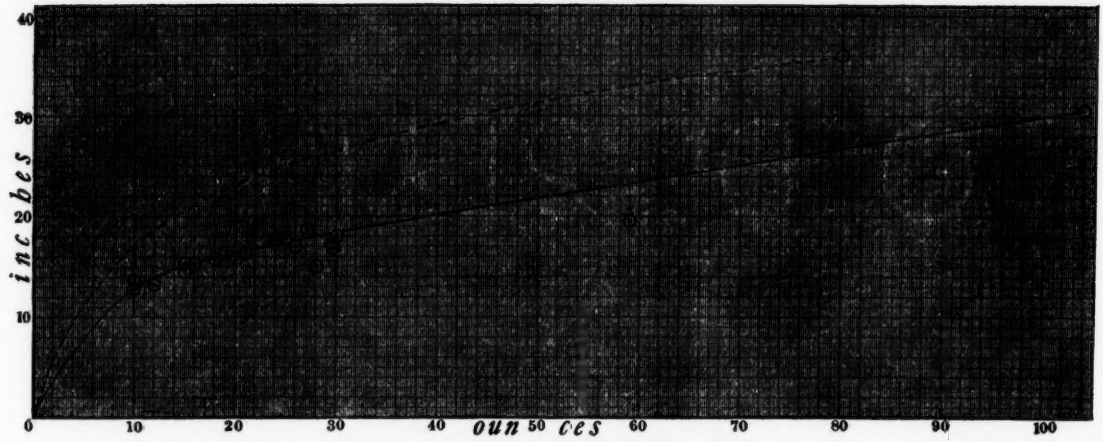
Of the twenty pike whose sex was determined, half were males. The males averaged about three ounces heavier than the females, but the data are not enough to warrant a general statement on this score.

If we represent the length of each fish by a corresponding distance measured along a vertical line and its weight by distance along a horizontal line we may show the length and weight of each by means of a point. Thus in figure one, each inch of length is represented by a space on the vertical line at the left; each ounce of weight by a space on the horizontal line. The intersection of horizontal and vertical lines drawn from the two points thus located gives a point which shows at the same time the length and weight of an individual fish. Thus the point at the extreme right in our figure indicates a fish of 30.6 inches length and 104 ounces weight. The remaining points indicate the lengths and weights of the pike in our table. Through these points we may draw a curve as shown in the figure. This curve

may be drawn with mathematical precision, but that would require a larger number of points than we have for the pike. The curve in the figure has therefore been merely sketched in. It represents the relation between length and weight of the 22 pike in the table. With sufficient data the relation might be expressed by a curve from which it would be possible to derive an algebraic formula.

The curve shows that as the pike grow longer the length increases less rapidly than the weight. Thus between the lengths of fifteen and sixteen inches there is an increase of nearly four ounces in weight, while between the lengths of twelve and thirteen inches there is an increase of but two ounces in weight. In other words the pike increases in weight about twice as much per unit of length between fifteen and sixteen inches as it does between twelve and thirteen inches.

Such a curve may very well be characteristic of the lake. It may indicate whether the conditions in the lake are favorable to pike, or it may have some other meaning. To see whether the curve has any meaning I attempted to find similar data from which to construct a curve for pike from some other locality. I was unable to find them and so far as I know they do not exist. In Forbes and Richardson's Fishes of Illinois the average length of the pike in Illinois is given as 36 inches and the average weight as 80 ounces, but it is not stated whether these averages are made from measurements or are mere estimates. If the point for a pike of 36 inches and 80 ounces is indicated on the chart it is seen, as shown by the broken line, to fall well above the curve for the pike of Douglas Lake. A hypothetical curve sketched through this point is seen to have a different form from the Douglas Lake curve. It rises more steeply and indicates a less rapid increase of weight per unit of length. In other words the pike represented by such a curve would be longer for a given weight. In Douglas Lake a pike of 80 ounces should be about 26 inches long, while in Illinois it is said to be on the average 36 inches



Curve showing the relation between length and weight in the pike (*Esox lucius*) of Douglas Lake, Michigan. The dotted line is a hypothetical curve for the pike of Illinois.

long. It is possible that such a curve represents conditions favorable or unfavorable according to its form, but at present we have no data from which to determine whether this is true or not.

It seems to me important that data such as are included in the table here shown be accumulated. By means of them we should learn much of the *conditions* under which our various fishes live. In addition to the data included in our table there might be added others on parasites, on breeding habits and breeding seasons, conditions of the sexual glands, character of bottom and of vegetation at the point where fish are taken, and possibly on the temperature of the water. A table of the form here indicated is shown below. It is suggested that a data blank of suitable form with instructions for its use be prepared and distributed to members of this society. This might be done by the United States Bureau of Fisheries and the blanks, properly filled, might be returned to the Bureau. In this way information about the conditions under which fish live would be gradually accumulated at Washington. Whenever the observer was uncertain as to a species of fish or the character of stomach contents, the specimens might be forwarded for identification. A study of the accumulated data would certainly add much to our wholly inadequate knowledge of the natural history of our fishes.

FORM SUGGESTED FOR USE IN RECORDING DATA CONCERNING FISH

Number	Weight ounces	Length inches	Sex	Sexual glands	Stomach contents	Parasites	Locality	Depth water	Water temperature	Kind of bottom	Vegetation	Net or tackle	Date	Miscellaneous breed'g habits etc.

1. Each fish should be given a serial number and the data concerning it entered in the appropriate columns opposite its number.

2. Lengths should be measured along the middle of the side from the tip of the snout to the base (not tip) of the tail fin.
3. By depth of water is meant the number of feet from the surface to point at which fish was taken.
4. Under the locality should be indicated name of body of water, and its location, and point in it at which fish was taken.

WORK OF THE PENNSYLVANIA FISHERIES DEPARTMENT.

By N. R. Buller,
State Commissioner of Fisheries of Pennsylvania.

Efficiency and economy are the greatest factors in success in the business world and they should be the greatest factors in the work of the officials that have charge of the fishing interests of the Government and the various States. Efficiency and economy are only attained by the use of the best possible methods and the best contrived plans. It was in view of this that the Department of Fisheries of Pennsylvania decided that the way to get the best results at the least expenditure of money, was to concentrate the work on a few plants and make those complete in every detail and up to the highest type of the requirements of fish lore.

There were eight hatcheries in Pennsylvania when the present Commissioner assumed control. One of these had been badly torn up by floods, and at another the water supply and the situation unfitted it for the work it was called upon to do. It was decided, therefore, with the advice of the Board of Fishery Commission, to abandon these two hatcheries and concentrate the work upon the other six, using each one for the propagation of the fish to which it is peculiarly fitted.

Engineers were employed to lay out the grounds and to draw up plans showing the capabilities of each hatchery in the way of the ponds adapted to its water supply. Architects were employed to draw up plans for hatching houses, to be of brick, concrete and steel with an absence of wood except in the window frames. This will make them almost indestructible and obviate constant repairs. The dignity of the Commonwealth of Pennsylvania demands that the buildings and the hatcheries shall be of a substantial and ornamental type that will make them a credit to the State.

From these plans the Department, during the past year, has gradually worked out the solution of the prob-

lem it had set itself to solve. At the Corry hatchery the series of ponds necessary to complete that hatchery were partly constructed of reinforced concrete in the best manner laid out by contract, thus insuring expert work. The contracts for the erection of the hatching house and the remaining ponds necessary to complete the hatchery have also been made, and the department hopes by next fall to have one of the most complete, if not the most complete trout hatchery in the United States. The water supply is ample and of the best quality. The lay of the ground is exactly suited for the construction of the ponds and the output from this hatchery ought, for several years, to be fully equal to any demand which may be put upon it.

The Wayne County hatchery is situated in the northeastern part of the Commonwealth, in the region which abounds with lakes that might be said to be breeding ponds for the propagation of such fish as pickerel, yellow perch, sunfish and bass. The capabilities of this hatchery for the furnishing of these fish is limited only by the amount of money that the State will appropriate for the purpose of field work, which is the name the Department gives to the work of gathering spawn and young fish from the various lakes and ponds.

The Department has secured the rights to a former reservoir of the Delaware and Hudson Canal, which has a water surface of several hundred acres, to be used as a bass pond, and this is supplemented by several ponds of varying sizes, which will be used as breeding ponds. The control of the reservoir gives the hatchery the control of the water, so that at no time will there be any danger of shortage of water. The facilities for raising trout at this hatchery are fully equal to any demands upon it in that section of the State. A new hatching house of the substantial character spoken of above will be erected this year at the Wayne hatchery, and it is hoped to have it in use this coming season.

Another important output from the Wayne hatchery is bull-frogs, the tadpoles of which can be gathered in

almost countless numbers from the various waters in the vicinity, and the Department will be able to furnish all the frogs that may be needed by applicants in the State. It is a rather curious fact that while these tadpoles may be gathered and shipped by the million this seems to have no effect upon the number of frogs remaining, which appears to be about the same every year.

At Torresdale is situated the shad hatching plant of the Department, and the past year it did wonderfully good work in the matter of hatching and planting shad, although the season was not a propitious one. The water failed to warm to the proper temperature, so that many of the fish hatched too early, but they were planted right off the hatching house and the Department hopes that there was no loss. In this shad work the Department had the co-operation of New Jersey and also, in a way, of New York to which latter State the Department was glad to turn over several million shad. That the work of the Department in the hatching and planting of shad has kept up the stock in the Delaware river is shown by the number of good hauls of shad taken as far up the river as Hancock and Cadosia in New York State.

At Torresdale the hatchery is also used to supplement the other hatcheries in hatching out in its batteries wall-eyed pike, white fish and yellow perch. This hatchery will also be used to furnish blue gills, sunfish and catfish, to the breeding of which the waters are thoroughly suited.

At Erie is situated the hatchery to propagate the lake fishes that go to make up the fishing industries of Erie, the largest fresh water fish port in the United States.

The spawn of these fish from the lake would be wasted were it not for the efforts of the fish culturist. About two years ago there was an epidemic of typhoid fever in Erie and the State Department of Health ordered the water treated, which proved deadly to the fish, and the work of hatching these fish has since been conducted at the Erie Auxiliary Hatchery, situated at Union City, about 18 miles from Erie.

In the plans for the completion of the hatcheries, Erie was, of course, included and to meet the problem of water the Commissioners of Water Works of the City of Erie donated to the Department of Fisheries a portion of the park at the water works. This is located on the lake and the Department's boat can land immediately at the hatchery door the eggs which have been gathered by the fishermen, and receive the young fish to be planted. The last Legislature has made an appropriation which will enable the Department not only to put up a complete hatchery, but at the same time erect a building ornate enough to be in keeping with the beauties of the park. The building will have a capacity to handle any ordinary catch, but it can always be supplemented, if overcrowded, by the batteries at Wayne, Torresdale and Union City.

At Union City much work has been done in the extension and completion of ponds and its success in bass work this year is most gratifying.

It will be understood that while all these works of completion were going on, the work of fish culture was badly hampered, but the Department is glad to say that the results have been most gratifying and every application for fish has been or is being filled in its turn. The Department has adopted a plan of shipping fingerlings, which in the trout run from three to seven inches in length, and in the other fish from two to four inches, except, of course, in such cases as that of the wall-eyed pike where the hatch is so enormous that the fish must be shipped as fast as they are hatched. This sending of the larger fish has met the warmest commendations of the recipients, and there is hardly one applicant who has not written to express his approbation.

The fish when shipped are counted and the applicant receives a notice telling how many fish are sent and asking him to state the number received and the condition. This seems a good innovation, as the Department now knows exactly how many fish were sent to an applicant, how many he received and their condition. It is

gratifying to say that not one return in a hundred complains of a loss of more than two or three fish, while all report the condition good.

While the Department has perfected its plans to furnish all the game fish required to stock the streams of the State, yet it knows that the number of anglers who want these fish are but a small proportion of those who go fishing in the State. To the expert angler with his slender tackle there is a thrill when the gorgeous colored trout or the greedy black bass takes his fly and starts to battle for his freedom. But the number of trout streams is but a small portion of all the streams of the State, while the black bass is not suitable for many streams.

To the majority of the dwellers in Pennsylvania, fishing is not only an amusement, but at the same time a means of obtaining a food supply. There is nothing equal to a day or a week in the woods beside a stream, where the sun brings the tan to the cheek and the fresh air a joy to the lungs that is not felt by the dweller in the towns and the worker in the stores and mills. The farmer and the farmer's boy, and even his wife and daughters, enjoy a fishing trip to the streams where they can secure a mess of fish which means a change of diet. At the same time, when they hook the fish with their plain tackle, they feel as exciting a thrill and experience as much gratification as the expert angler who takes the trout or bass with his expensive apparatus.

To this very large majority of fishermen the joy of fishing is brought by the so-called minor fish—the yellow perch, the sunfish and the catfish, together with such native fishes as the chub and the fall fish. All these fish are easily propagated and have great fecundity and the Department will bend every effort to produce these in such numbers that every one may have not only the pleasure of fishing, but the pleasure of taking home a string of fish to eat. There would be no difficulty in keeping these streams stocked with fish but for the wasteful and destructive methods employed by too many

persons who have no regard for the rights of others. The man who draws off a dam for the sake of getting a bushel of fish and thereby destroys thousands of other fish has no regard for the Golden Rule. The same is true of the gigger and the seiner, but the Department hopes, with the education of the people to the fact that the streams will be full of fish if they are properly protected, that the days of destructive fishing will soon be numbered.

The Department is glad to say that it finds no part of its work so popular as the plan to fill up the streams with fish for the general public.

The problem of clarifying the streams of Pennsylvania is one of the most serious that the Department of Fisheries has to face. Ever since the settlement of Pennsylvania manufacturers have seemed to regard the streams as open sewers into which it is perfectly proper to discharge their refuse with no thought of the discomfort to the man down stream. There are now about 48,000 manufacturing establishments in Pennsylvania and all, or nearly all of them that have the opportunity, empty their refuse into the nearest stream. The result, of course, has been to foul the streams in such a way that many of them no longer contain any aquatic life whatever, while hundreds of other streams are so foul that the fish avoid them or live in them only in very small numbers.

For two years the Department has pursued a plan of notifying every manufacturer that he must comply with the law which forbids running into the streams any matter deleterious to fish or aquatic life, so that no one can plead ignorance of the law. The prosecution of sporadic cases the Department has found of little value, making no impression. Indeed, in one case where suit was brought against the manufacturer, who was allowing lime to run into one of the worst polluted streams in the State, the manufacturer placed on the stand a skilled chemist who testified that the amount of effluent going from the manufacturer into the stream, would soon be

so neutralized by the volume of water that it would be no stronger than the lime water with which a mother mixes the milk for her child. On this testimony the manufacturer was acquitted, and the Department is now co-operating with the Department of Health in a campaign in which every manufacturer, from the source to the mouth of the stream, will be notified that he must conform to the law within a certain date or prosecution will be brought against them all.

This is the plan that the Department intends to pursue in the future. One water shed will be taken and every manufacturer situated on that shed will be compelled to abate the nuisance, or as a last resort, the Department will sue out an injunction. This latter is a drastic method and one to be adopted only when it becomes absolutely necessary to force the offender to terms. The Department is sure that it is backed up by public sentiment in this course, because it is plainly evident that the people of the Commonwealth will no longer stand for the defilement of the waters, which keeps them barren of fish and renders them useless for domestic purposes.

The Supreme Courts of New York and Indiana have decided in a pollution case that the persons on a stream are entitled to the water as pure as when it left the source. Nature knows no such thing as waste and modern science has shown that any waste flowing from a manufacturing establishment is a distinct economical loss. As long as there was only one manufactory on the stream the manufacturer did not feel any economical loss himself because the water was polluted, but when the man above him began to run in refuse in such quantities that he was compelled to put in a purification plant to get his water clear, he began to realize what pollution means, and the Department finds more manufacturers who are ready to co-operate with it than it does those who are willing to make a fight.

DISCUSSION

MR. NESLEY, of New York: I wish to ask Commissioner Buller how the cost of the bass gathered in the field would compare with that of

those raised in the hatchery ponds, and my reason for asking is that I have always believed that spawning bass gathered in the field would not cost more than one-tenth of those reared for the purpose. The work of gathering would extend only over a couple of weeks, while otherwise the salaries of hatchery employees must be paid for the whole year.

MR. BULLER: I cannot answer the question as the work was done by our regular trained employees who are employed the whole year through and their expenses would be the same whether they worked in the field or in the hatchery.

PRESIDENT: I would suggest to Mr. Nesley that if everybody were to work in that way the natural crop would become exhausted.

MR. WOODS, of Missouri: What is the cause of the pollution of the water of which Commissioner Buller complains?

PRESIDENT: Two or three years ago I had occasion to address this Society on the pollution of streams. At that time the streams in western and especially southwestern Pennsylvania were foul with the yellow sulphurous offal that comes from exhausted coal mines, and there were no fish, frogs, insects or other living things in these streams.

MR. BULLER: I recently made two trips through western and southwestern Pennsylvania to make observations on the pollution of streams by coal mines and large manufacturing plants. Not even a typhoid germ will live in those waters. The pollution comes from various manufactories, paper mills, etc., and coal mines. One paper mill that I particularly studied spends thousands of dollars weekly to purify the water for a certain process, then runs its own refuse into the stream for the next man below.

PRESIDENT: The Chair will take occasion to say to Mr. Woods that the causes of pollution are numerous. There are wastes from all sorts of manufactories and others due to dense population. There are rivers here in New England that are a dangerous asset. They are so black that nothing will live in them, and the same is true of those of eastern New Jersey. The Ohio River is very nearly an open sewer below Pittsburgh, and carries disease to the towns below. The task of cleaning up many rivers in the United States is a herculean one.

MR. BULLER: In this campaign which the Department of Health and the Department of Fisheries are making in Pennsylvania, ninety-five per cent. of the manufacturers are in full accord with us and are spending thousands of dollars with the result that they have eliminated much of the pollution, but it is a stupendous task. The difficulty is to find a way to take care of the large quantities of polluting material.

PRESIDENT: Most of you are aware that a great deal of our effort in fish culture in this country is lost on account of the pollution of the water. We are pouring young fish into streams, which, while pure at their head-waters, are impure and unfit for fish life farther down. It is evident that we are approaching the point where the pollution nuisance will be intolerable and we will have to clean up as they have done in many parts of Europe. Factory wastes can be made into by-products, and sewage can be converted into fertilizer for the soil. This nuisance can be abated whenever the courts make it too expensive for manufacturers to continue as they are now doing.

MR. THOMAS, of Virginia: In western Pennsylvania there are forty thousand coke ovens which have allowed all the gas to go to waste. But at Bethany the gas is made use of to run their own furnaces and to furnish the city with gas at the same time, and not one thing is allowed to go to waste. That is a sample of what can be done by scientific methods.

MR. RIDER, of Minnesota: Will deposits of corncobs from canning factories pollute the water to the detriment of the fish?

MR. EVANS, of Pennsylvania: In a recent canning factory fire in my State a great many cans of stuff were exploded by the heat. The contents fermented in the stream and killed the fish. Corncobs would sour in a similar manner and be a menace to the fish.

PRESIDENT: I happen to be the author of a somewhat lengthy paper on the pollution of streams. If any member desires to go into the subject I will be glad to mail him a copy on receipt of his address.

CONDITIONS REGULATING THE GROWTH OF THE CLAM (*Mya Arenaria*).

By David L. Belding,
Biologist of the Massachusetts Department of Fisheries and Game.

It is with some hesitation that I submit for your consideration an old, though interesting, subject; but I desire to approach it from a viewpoint slightly different from that taken by previous writers. I desire briefly to outline the more important natural conditions which regulate the growth of lamellibranch mollusks, using the soft clam (*Mya arenaria*) as an illustration. In the future the tidal flats of Massachusetts will undoubtedly be covered with numerous clam farms. Therefore, from a practical standpoint, a knowledge of the conditions which influence clam growth will be of value to the culturist in the selection and development of his grant.

In the tidal waters clams are present in abundance on some flats, in scattering quantities on others and in many sections entirely absent. The reason is that certain definite conditions are essential for a favorable environment. There is no more convincing illustration of the influence of environment upon the life of a clam than the effects of the surroundings upon the rate of growth. Chief among these natural forces may be enumerated current, tide, soil, depth and salinity of the water, so closely interwoven that their separate action cannot always be clearly demonstrated. Any discussion of these conditions, which form a favorable or unfavorable environment, involves their separate treatment; but it should be understood that there are few, if any, instances where the pure uncomplicated action of a single natural condition can be obtained. These factors naturally fall into three main groups: (1) the circulation of the water or the current; (2) the condition of the water; and (3) the character of the soil.

Current.—The most important factor in clam growth is a good current, not necessarily an exceedingly swift

flow, but rather a fair circulation of water. The varied services of the current render it of special importance to the culturist in the selection of a grant since the productive capacity of clam flat depends almost wholly upon the circulation of water. It is a well known fact that the growth of the clam is more rapid where the water is in constant motion than in still water, and it has been commonly considered that this difference is due to the increased amount of food, the clam in the current receiving the greater food supply. But rapid growth in a good circulation of water is a more complex problem than a simple increase in the available food supply, and it is the main object of this paper to show that our previous explanation of the effect of current on growth is only partially correct. Current affects the life and growth of the clam in many ways, but chiefly by regulating (1) the food supply, (2) the amount of available oxygen, (3) the feeding habits, (4) the secretion of lime salts and (5) the sanitary conditions.

Food Carrier.—An important work of the current is that of carrying food. The clam obtains its nourishment from the microscopic forms, which are generally distributed throughout all waters, although different localities vary in abundance according to the conditions favorable for their reproduction. The growth of the clam, as with lower animals, is directly proportional to the amount of food consumed, and the animal situated in a current naturally receives a greater food supply than one in still water. For all practical purposes current means food, and within certain limits the increase in current indicates the increase in quantity of available food, thus furnishing an approximate index of growth. Since the clam is a stationary animal with a limited feeding range, it is obvious that a maximum point of food assimilation can be obtained, when the clam will be unable to take in any more food from a swifter current. For this reason the term current, as used here, implies only a good circulation of water and not an exceedingly swift flow.

Oxygen Bearer.—The relation between the amount of food, the supply of oxygen and the feeding of the clam in a current is comparatively intricate and the exact proportion that each factor contributes to the increase in growth, as far as figures are concerned, is somewhat problematical. Oxygen, the most important, affects growth in two ways, first by increasing the metabolism of the body, and second by stimulating the feeding activities of the clam, but so closely are these actions connected that it is impossible to determine their relative values. Oxygen is needed for life and with an increase in the amount of available oxygen the bodily functions are performed more readily. The usual supposition that the effect of current upon clam growth was entirely due to the actual increase in food forms was disproved in 1907 by an experiment, which demonstrated that the increase in the food supply was only a partial explanation. The results indicated that the beneficial action of the current consisted rather in increasing the clam's power of assimilating food. By the following method an approximate idea of the actual increase in the food supply as compared with the total increase in growth for hard clams in still water and in a current was obtained.

At Monomoy Point, Massachusetts, the rate of growth had been followed for several years for two experimental beds of hard clams, the one in still water showing a slow growth, the other with a good circulation of water having a much greater increase. To test the relative difference in the amount of food forms at a definite point on these beds small nets of silk bolting cloth, No. 11, two inches in diameter and four inches long, were so arranged that they would rotate on an iron rod after the manner of weathervanes. When in position the nets remained extended in the water and on the slightest motion would swing on a pivot, thus always presenting the opening of the net to the current. One net was placed over the bed in still water, the other, identical in every respect, was situated over the bed in the current for the same length of time. After having been down a certain num-

ber of hours they were taken up, the contents of the nets washed into a small quantity of water, and the food forms counted by means of the Rafter cell, the approximate number of standard units per cubic centimeter in each case being determined. Two parallel sets were run at three different times, ranging from eight to eighteen hours each. The total number of standard units per cubic centimeter for the current was 2,188,800, for the still water 1,612,800, giving a gain of 35.7% for the current. The annual growth of the hard clams in the current showed a gain of 24.5 mm. or 612% by volume as compared with a gain in the still water of 13.62 mm. or 241% which was 2.6 times as much. These figures are at best only approximate but are sufficient to show that there is a great discrepancy between the actual increase in the food supply and the rate of growth. Numerous errors are possible in this test; in the placing of the nets, in the technique of counting, and by comparing the yearly growth with the food supply for a short period; but the vast difference is striking, since it is apparent that the 35.7% gain in food cannot account for the great difference in growth, and we are justified in concluding that other factors, one of which is an increased supply of oxygen, are even more important.

Observations upon clams in aquaria in still or even stagnant water show that they feed but a small portion of the time, lying with their siphons partly extended in a semi-dormant condition. In these cases, if the water is slightly agitated by blowing upon the surface, the clams stretch out their siphons and begin to feed actively, showing the stimulation from the circulation of the water. Practically no growth has been obtained from clams in still water aquaria, in spite of the fact that they have been well supplied with food forms. A possible explanation is that current serves in some way to stimulate the feeding of the clam and in this manner increases its powers of assimilation.

Lime Furnisher.—Current also furnishes the clam with the lime salts in solution in the water, which are

utilized in forming the shell, a process as essential to growth as the assimilation of food. The lime salts are obtained from the water,—since it has been shown that clams will grow out of sand,—and are transformed into a suitable form for shell secretion in the body of the clam. The assimilation of the calcareous salts depends upon the temperature, the activity of the animal, the quantity in solution and the current.

Sanitary Agent.—The work of the current as a sanitary agent consists in removing decomposing matter, silt and decaying organic material, thus preventing the spread of disease and the destruction of thickly planted beds.

Water.—The composition of the water, organic and inorganic, soluble and insoluble, and its physical characteristics influence the growth of the clam. The soluble constituents, chiefly the nitrogenous salts upon which the miscroscopic food forms subsist and the lime salts for the shell, indirectly affect the rate of development. The insoluble material, such as silt and sediment of various kinds, tend to interfere with the feeding of the clam, which starves itself by mechanically throwing off both food and silt from its gills. The insoluble food forms, on the other hand, are of value for the nourishment of the clam. Likewise the physical characteristics of the water, such as salinity, temperature, depth and tide may influence the existence of the clam.

Salinity.—The clam will grow in nearly all degrees of salinity, even as great a range as from 1.004 to 1.024. It can be transplanted from waters of low salinity to high or vice-versa without apparent harm, an interesting fact for the culturist, and in this respect is in striking contrast to the oyster, which is affected by the slightest change in salinity.

Temperature.—Temperature is the great controlling factor which regulates the growth, habits and existence of marine animals, differentiating the fauna and flora of one region from another. With the clam, temperature explains the faster summer and the slower winter growth,

the warm water stimulating the assimilation of food and the secretion of the shell while the cold water causes the animal to become sluggish.

Depth.—Little difference has been noticed in the growth of clams suspended in sand boxes at various depths, and since the habitat of the clam is between the tide lines the question of depth is of little importance. In enclosed bays the deeper layers of water do not always have as good a circulation as the shallow waters, which are disturbed by wind and wave action; but in the tidal rivers the deeper waters have the stronger current.

Tide.—Although the natural home of the clam is between the tide lines, submerged beds are occasionally found below extreme low water mark and numerous experiments in Rhode Island and Massachusetts have demonstrated that submerged clams grow faster owing to a longer feeding period. A series of beds extending from high to low water mark shows a gradual increase in growth as low water mark is approached. Assuming that the clam feeds continually when under water, an increased daily exposure materially lessens the amount of food consumed, an assumption that is open to the criticism that the clam may not feed continually and that the lower beds have a better circulation of water. The latter objection has been eliminated by parallel experiments where the only difference was the exposure.

Soil.—Soil is a less important factor in clam growth than is commonly supposed and affects the growth in two ways, indirectly by affecting the quantity of food, and directly by affording a resting place. Soils vary in their capacity as breeding grounds for the production of the microscopic food forms, which multiply upon the surface of certain flats. The direct action of the soil is largely mechanical and the actual character affects the shape, flavor and growth of the clam. Dr. J. L. Kellogg states that a tenacious sand (fine sand with a little cementing mud) furnishes the best medium for the clam, both from the standpoint of growth and easy digging. Nevertheless clams grow in nearly every kind

of soil provided that it is not shifting sand or soft mud. Even in such cases exceptions are frequently noticed, clams often being present where there is moderate shifting, while large clams are occasionally found in extremely soft mud. To insure the best growth, the soil should be free from decaying organic matter, it should be of firm consistency, not readily affected by storms or currents and free from substances which might injure the clam. Any soil possessing these qualifications, no matter its exact composition, is suitable for clam growth.

Soils may be grouped into three main classes, sand, mud and gravel, with many intervening combinations. Flats of fine sand, usually swept by a current, furnish the best appearing clams with a smooth white shell in marked contrast to the rough and deformed gravel clam. Mud flats are usually situated where there is little current or where streams deposit material from the land and in most instances produce a slower growing clam. Gravel flats, though less extensive, nearly always contain clams which by reason of their environment have a heavy protecting shell.

Unproductive Soils.—Tidal clam flats are of two classes, productive and unproductive. Usually the boundary line is sharply marked, but at times no noticeable difference can be seen except that one flat produces clams while the other does not. The unproductive flats can be further grouped into permanent and temporary, the latter including the flats where clams will grow if planted, but which either do not receive the set, or owing to changed natural conditions are temporarily unproductive. This type of flat is especially adapted for clam culture. The permanent barren flats comprise soils that can never be reclaimed, soils that can only be utilized after considerable expense, and soils that can be made productive at a slight cost.

There are several classes of unproductive soils. (1) Soft mud smothers the small clams, prevents the set by reason of its slimy surface and, by the fine particles of silt, interferes with the mechanical feeding of the

clam. (2) Eel-grass prevents the circulation of water, collects slime and silt and furnishes a mass of decaying material injurious to the clam. (3) Mussels ruin a clam flat by collecting soft mud, covering the clams and utilizing the same food. (4) Organic material from various sources in a soil corrodes the shell and interferes with the shell-forming properties of the mantle. In certain river flats manufacturing wastes, chiefly of the petroleum group, render the clams unpalatable, the surface unfit for set, and, in extreme cases, may destroy the adult clams. (5) Shifting sand does not favor the growth of clams, although adult clams will stand a surprising amount of shifting. Flats with a slightly rippled surface are barren because the young clams cannot get a permanent foothold, but such soils respond to cultivation provided that the shifting is not too severe and that large seed clams are planted, although the culturist runs the risk of storms and swift tides destroying his crop.

Practical Application.—The points brought out in this paper are of practical application in two ways, to the clam culturist in selecting the location of his grant and as a basis for methods of reclaiming a large area of barren flats. The only way the tidal flats of Massachusetts and other states can be made truly productive is by a system of individual leases under which every fisherman can have a salt water farm for the production of shellfish.

In selecting his grant the prospective culturist should bear in mind that the current is the most important guide, since the productive capacity of a clam flat depends chiefly upon the circulation of water, and he can follow the general rule that as long as the flow of water does not harm the clam in other ways the swifter current gives the faster growth. Yet he should not forget that there may be disadvantages as well as advantages, excessive action causing the shifting of the flat, destruction of clams and the prevention of set, and that no hard and fast rule can be stated.

Thousands of acres of barren flats may be reclaimed by such means as artificially directing the tidal currents, seeding with small clams, covering soft soils with sand or gravel, draining certain areas, and forming a tenacious surface by planting thatch on smooth current-swept flats. Each flat represents an individual problem and special methods must be adapted for each case.

Summary.—In this paper I have endeavored to bring out the following points: (1) The environment of a clam is the result of many complex forces, some of which I have enumerated, so interwoven in their action that it is difficult to definitely determine their separate influences. (2) The existence of the clam depends essentially upon three groups of conditions, the current, the water and the soil, while the *rate of growth* from a practical standpoint depends chiefly upon the *current.* (3) A knowledge of the relative value of these factors is of importance to the clam culturist. (4) The former prevailing explanation that current achieves its result by merely increasing the amount of available food is entirely inadequate. The actual increase in the food forms by no means accounts for the much greater growth, which is evidently due to the increased powers of assimilation of the clam either directly by the stimulation of the current or indirectly by the supply of oxygen.

DISCUSSION

MR. LYDELL, of Michigan: Is it possible for fresh water clams to get into a pond unless the clams themselves are carried there? We have a pond that was dug in the soil eight or nine years ago and it is now filled with the fresh water mussels.

PRESIDENT: The larvæ of fresh water clams are temporary parasites on certain kinds of fishes. These larvæ attach themselves to the gills and fins of these fishes until they reach a certain stage of development. Your fishes probably transferred the clams to the pond in this stage, after which they dropped off and grew to maturity.*

PROF. DYCHE, of Kansas: What is the geographical distribution of this species of salt-water clam?

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*See "Studies on the Reproduction and Artificial Propagation of Fresh-water Mussels," by George Lefevre and Winnerton C. Curtis, in Bulletin of the Bureau of Fisheries, Vol. XXX, 1910, pages 105-201, plates 6-17.—*Editor.*

MR. BELDING: I do not know the exact range of the species. It runs northward to Canada and as far south as Carolina. It is abundant in Maine, Massachusetts and other New England States.

PRESIDENT: The introduction of the Eastern soft-shelled clam to the Pacific coast was one of the early moves of the Fish Commission and met with great success. I happened to be living in California after the clam got fairly established. If you were to go along the shores of San Pueblo Bay today at low tide you would find many clam diggers at work. This clam is highly appreciated in the San Francisco markets. We cannot get along without the clam on this coast, and we shall eventually adopt means for cultivating it.

THE SEA MUSSEL INDUSTRY.

By Irving A. Field,
Asst. Prof. of Biology, Clark College.

Three years ago at the New York meeting of this Society I presented a paper which dealt with the food properties and commercial value of the sea mussel. Attention was called to the fact that in Europe there was a large and ready market for this shellfish, while in America New York City was the only place where any sale could be found for them. In the present paper it is my purpose to outline the development of the sea mussel industry, to show what is being done in Europe, what we are doing in the United States and what we ought to be doing in the way of utilizing this valuable but hitherto almost neglected mollusk.

The origin of mussel culture was in the Bay of Aiguillon on the west coast of France in the year 1235. The inventor of the system was Patrick Walton, an Irish sailor, who was shipwrecked on that coast and rescued as the sole survivor of his ill-fated vessel. He was kindly received by the native fishermen and invited to make his home with them. In return for their cordial hospitality he was able to give them a rich and lasting reward. Previous to his arrival the fishermen of that region had made poor success at earning a livelihood, but Walton, who was a most ingenious fellow, was quick to perceive the wealth which might be obtained from the neighboring great swamp of mud. Starting out to make a living by capturing birds in a net which was suspended between stakes driven into the mud of the swamp, he soon observed that young mussels were attaching themselves in enormous numbers to the wooden supports. He noticed that they grew with great rapidity and that they were of superior quality and flavor to those which grew on the mud. The conclusion was quickly reached that mussels could be profitably raised on wooden frames, and Walton promptly put this idea into practice with a suc-

cess that has brought a lasting blessing to the several villages which border the Bay of Aiguillon.

The system of cultivation which was finally devised by Walton consists of a wicker work constructed on rows of stakes arranged in the form of a V with its apex pointing toward the open sea or direction from which the strong waves and tide come. This arrangement is to protect the structure from the destructive action of the wind, waves and ice. The stakes are trunks of trees 6 to 12 inches in diameter and from 10 to 15 feet in length. They are placed from 2 to 3 feet apart and driven into the mud for about half their length. Then branches of osier or chestnut are twisted back and forth between the posts in horizontal rows about 20 inches apart from the top to within a foot of the bottom. If placed closer together than this they are apt to accumulate mud and cause deposition of silt. Walton left an opening 3 to 4 feet wide at the apex of the two wings where traps were placed to catch the fish which went out with the tide, thus making the structure serve a double purpose.

The length of the wings depends on the size of the area covered by the tide, which is about one-fourth of the distance between the extreme limits of high and low water. At the present time in the Bay of Aiguillon they are about 250 yards in length but are no longer arranged in the historic V form. They are now placed at right angles to the shore in parallel rows, about 30 yards apart.

The buchots are arranged in several series from the deep to shallow water, but in general three groups are recognized according to the function they perform. One set consists of large, solitary stakes placed about 1 foot apart out in deep water where they are uncovered only by the lowest tides. These serve for the collection of spat and are known as the low crawls.

The second series of buchots is placed half way between tide marks and serves for the growth and fattening of the mussels. Several rows of crawls, each with

a separate name, may enter into this series. The general term applied to members of this group is false crawls.

The third series of buchots is situated in the upper limits between tide marks where they are exposed several hours each day during low water. They are known as the high crawls and serve to inure the mussels to exposure and consequently make them keep longer and fresher than those from the lower rows.

The method of working the buchots is to collect the seed mussels and transfer them successively from the lower to the higher crawls at the proper times. Spat is liberated in the Bay of Aiguillon during February and March and is caught on the low crawls which are situated in an ideal location for the preservation and growth of the young shellfish since they are rarely exposed to the air. When the set of spat first appears the young mollusks are smaller than a seed of flax and are called *naissan.* The young mussels grow rapidly so that by July they reach the size of an ordinary bean. In this condition they are termed *renouvelain.* They are now ready for transplanting.

The seed mussels are scraped from the low crawls by means of a hook set in a handle and are placed in a characteristic type of basket. The mussels are then loaded into a special form of mud boat or "acon" which is also an invention of Walton's. The boat is made of a plank about 10 feet long by 2½ feet wide bent up in front to form the bottom and prow. The sides and stern are each composed of straight boards about 1½ feet wide. The boat is further reinforced by a shelf in the stern and a narrow thwart close to the bow. A board may extend across the middle to serve for a seat or it may be replaced by a wooden stool. A paddle and a short pole complete the equipment. When the boatman wishes to travel over the mud flats he faces the prow of the boat, puts his left knee on the bottom and thrusting his right leg, encased in a long sea boot, over the side of the boat, pushes it along. By this means he is able to glide over the mud at a rapid rate. When shallow water is

reached navigation is accomplished by means of the pole and when deeper water is encountered the paddle is used. The seed mussels which are collected from the low crawls are transported by this means to the false crawls or next higher row of buchots where parcels of them are attached to the wicker work by means of old netting. The shellfish immediately begin to attach themselves to the wooden structures by their byssal threads, so that by the time the netting has rotted or washed away, they are firmly united to the crawls.

The rate of growth in this position is very rapid and in a few months they become so crowded as to almost hide the frames. It then becomes necessary to transplant them again, this time to the next series of crawls lying nearer the shore. The mussels are attached by the same method previously employed but are not fastened so securely since they are able at this stage to attach themselves to the buchots much more quickly. After one year's treatment on the crawls the mussels reach a length of 1¾ to 2 inches, which is marketable size.

The net returns from an investment in a series of buchots is approximately 11½%. To quote from Coste, the production and value of cultivated mussels in the Bay of Aiguillon is as follows:

> A bouchot well stocked furnishes generally, according to the length of its wings, from 400 to 500 loads of mussels; that is to say, about one load per meter. The load is 150 kilograms, and sells for 5 francs. One bouchot, therefore, produces a crop weighing from 60,000 to 75,000 kilograms, and valued at 2,000 to 2,500 francs; from which it follows that the crop from all of the bouchots united would weigh about 30,000,000 to 37,000,000 kilograms, which, at the figures already given, would be worth about 1,000,000 to 1,200,000 francs. These figures and the abundant crops from which they result, give an idea of the food supplies and of the great benefits that may be derived from a similar industry, if, instead of being confined to only one portion of the Bay of Aiguillon it should be extended to the whole of it and carry it from the locality where it originated to all the coasts and salt water lakes where it could be successfully carried on. In the meantime the prosperity which it secured to the three communes of which it has become the patrimony will remain as an end worthy of effort; for, thanks to the precious invention of Walton, wealth has succeeded poverty, and since the industry has been developed here no healthy man is poor. Those whose infirmities condemn them to idleness are cared for in a most generous and delicate manner by the others.

Other methods are also employed in France for the cultivation of mussels. In some places they are raised in claires or artificial reservoirs the same as oysters, especially in places where the abundance of mud and silt renders oyster culture difficult.

A modification of the buchot method of myticulture is employed in a part of the Lamotte Canal near Marseilles. The canal is one of the branches which puts the sea in connection with Berre Lake and is traversed back and forth continuously with the tidal waters which contain great quantities of diatoms and infusoria making it an especially rich place for the cultivation of mussels. Because of the slight rise and fall of the tide in this stream it is impossible to use the bouchot system of culture. In place of it claies or movable wooden frames are placed vertically between grooved stakes on which they can rise and fall by means of a floating axis. The grooved stakes are mounted with a cross tree bearing a ring on the under side. The frame is surmounted with a hook so that it can be raised from the water and hung on the ring of the cross tree above. With this device the mussel culturist can at will, gather, replenish, wash or do any necessary work and when through return the frame to the water.

The capacity of one of these claies is about 10,000 mussels weighing from 660 to 880 pounds. The young mussels are collected on the shores of Berre Lake and placed on the claies by the same method employed for fixing seed mussels to the buchots. When of sufficient size they are marketed without any further transplanting.

Still another means for collecting spat and rearing mussels is by means of the raft collector. It consists of a raft from which hang planks or frames in a vertical position. It is anchored in a region where mussels are spawning and when covered with spat is towed to a breeding basin where the rearing can take place without any further care than to see that no mud accumulates on the frames. The chief objection to this contrivance

is that the planks or frames decay rapidly, often causing an entire loss of the harvest.

Myticulture is also practiced in Italy, especially in the vicinity of Taranto, where mussels are raised to supply the southern markets of the peninsula as far north as Rome. Here the shellfish are cultivated on ropes made from rushes or "alfa" suspended in the water from stakes which are placed from 20 to 30 feet apart depending on the depth of the water. The ropes are hung over the mussel beds close to the shellfish in order to catch the free swimming young. Six months after a set of spat has occured the ropes are taken up and all the shellfish on them which have attained the size of an almond are removed. The smaller ones are left to grow until the following season when they will have attained sufficient size for food purposes. The larger mussels selected are interlaced, either singly or in bunches, into ropes which are then suspended vertically from a main rope extending between two stakes planted out in deep water. Parks are also utilized in the culture of mussels by this means, some of them extending 2600 to 2925 feet into the sea. The yearly yield of such a park is 40,000 to 50,000 pounds worth from $880 to $1,100.

In Germany the Bay of Kiel contains extensive areas where mussels are cultivated. The method employed at this place is to drive stakes into the bottom and leave them there for a period of from 3 to 5 years, during which time they become covered with mussels of marketable size. They are then taken up, stripped of the shellfish and replaced by others. About 1,000 stakes are planted annually in this locality from which the yield of mussels amounts to about 800 tons.

The systems of myticulture so far mentioned are adapted for regions where the bottom is composed of mud too soft to support a bed of mussels and where there is considerable rise and fall of tide over large areas. Where the bottom is hard or covered with only a thin layer of mud, and silt is not being deposited rapidly, a much more economical method of cultivation is merely to

transplant the mussels from crowded situations to more extensive areas where food is abundant. It is in this manner that mussels are grown for the market in England and for that reason is often spoken of as the British method to distinguish it from the French or buchot method. The practice is to collect young mussels from salt water and sow them on artificial beds in favorable localities. The best regions for planting are estuarine flats where there is plenty of sand and gravel covered with mud rich in diatoms, infusoria and spores of algæ. Care should be taken to avoid planting the beds where they will be uncovered at low tide or subject to the ill effects of floods, gales, shifting sands or frost.

The advantages of the bed system are being recognized in other countries. It is recommended in Belgium, Scotland and Norway. Some of the progressive fishermen in this country have recently put the transplanting method into practice with great success in certain regions of Long Island Sound. In one case a fisherman was paid by an oysterman to remove great quantities of mussels which were growing on and about his oyster beds. The fisherman carefully planted them at the mouth of Oyster Bay and three years later dredged them up by the hundreds of barrels which he sold in New York at a net profit of $.75 per barrel. For two months he was able to market 100 barrels daily which will indicate the income he was able to derive from this business. It is needless to say that this man is still cultivating mussels.

The yield from a crop of mussels is something enormous and difficult to comprehend. In agriculture corn is considered one of the most prolific and valuable of farm products, producing in maximum 246 bushels to the acre. If marketed at $.75 per bushel the farmer realizes $184.50. However, when compared with a crop of mussels this yield appears small. Estimates for the English beds allow an average yearly production of 108 tons per acre, valued at $262.00. Mr. Geo. A. Carman reports that the artificially planted mussel beds in the vicinity of New York produce from 4,000 to 6,000 bush-

els per acre which at the market price of $.40 per bushel amounts to a value of $1,600 to $2,400. Allowing 3 years for the growth of these beds it leaves an annual average income of from $500 to $800 per acre. Furthermore, the time and labor required to plant and care for an acre of mussels is almost nothing compared with that expended by the agriculturist in raising his grain.

The importance of the mussel fishery in Europe ranks second only to that of the oyster among the shellfish industries. The statistics have been difficult to secure with any degree of completeness but what few official reports have been obtained show that the total value aggregates close to a million dollars which is distributed among the countries as follows:

Country	Quantity: Pounds.	Value: Dollars.
France	90,044,010	$559,276
Belgium	56,129,356	255,133
Netherlands	3,737,481	23,300
Ireland		15,510
Portugal		12,275
England	3,519,860	15,125
Germany	370,100	2,375
Total		$882,994

Dr. Ray Lancaster in his article on the mussel in the Encyclopedia Britannica states that in 1873 the mussels exported from Antwerp to Paris to be used for food were valued at $1,400,000. If this production still continues the total yearly value of the mussel fishery for Belgium and France alone equals nearly $2,000,000. This indicates how the mussel is appreciated in Europe.

In the United States, although exceedingly abundant, the value of the sea mussel as a food product remains almost unknown. The quantity and value of sea mussels marketed in the United States for food, bait and fertilizer in 1908 was as follows:

State.	Quantity: Pounds.	Value: Dollars.
New York	8,175,000	$8,200
California	68,000	1,600
New Jersey	287,000	1,400
Connecticut	7,200	200
Rhode Island	3,500	100
Massachusetts	1,100	100
Total	8,541,800	$11,600

To look at these figures, then at the extensive mussel beds and then at the facts concerning the chemical composition, nutritive value and low cost of this shellfish will convince any one that we have been neglecting one of the great and valuable resources of the nation.

A glance at the following tables which are based on data collected from unprejudiced sources will be sufficient to show the great superiority of the sea mussel as a food over the other shellfish commonly sold on the market.

COMPARATIVE COMPOSITION AND FUEL VALUE OF CERTAIN SHELLFISH.

Species	Refuse	Water	Protein N x 6.25	Fat	Carbohydrate	Ash	Total nutrients	Fuel value per pound
	P. ct	*P. ct*	*P. ct*	*P. ct*	*P. ct*	*P. ct*	*P. ct*	*Calories*
Sea Mussels	46.7	44.9	4.6	0.6	2.2	1.0	8.4	150
Lobsters	61.7	30.7	5.9	0.7	0.2	0.8	7.6	141
Long Clams	41.9	49.9	5.0	0.6	1.1	1.5	8.2	136
Round Clams	67.5	28.0	2.1	0.1	1.4	0.9	4.0	68
Oysters	81.4	16.1	1.2	0.2	0.7	0.4	2.5	41

COMPARATIVE COST OF PROTEIN AND ENERGY FURNISHED BY SEA MUSSELS AND OTHER SHELLFISH.

Species	Price per pound	Cost 1 lb. of protein	Cost of 1000 calories of energy	Amounts for 10 cents		
				Total wt. of shellfish	Protein	Energy
				lbs.	*lbs.*	*Calories*
Sea Mussels	$0.01	$0.22	$0.07	10.00	.806	1500
Long Clams	.04	0.88	0.29	2.50	.125	340
Oysters	.03	2.51	0.68	3.33	.040	147
Round Clams	.05	2.38	0.75	2.00	.042	136
Lobsters	.18	3.05	1.29	0.556	.033	77

It is evident from the facts recorded in the above table that from the standpoint of economy the sea mussel surpasses all other shellfish foods by a wide margin. The same amount of money spent for mussels as for long

clams will purchase more than four times as much energy. A similar comparison with oysters shows that the amount of energy supplied by mussels is ten times as great while with lobsters it is nearly twenty times as much. Not only is this shellfish an abundant and economical food, but it is tender, of fine flavor, and it has been shown to be as digestible as steamed beef. A French writer has expressed its food qualities by the following ratio: "Mussels are to oysters as potatoes are to truffles." In other words mussels are a substantial, economical food, not a luxury.

The conclusion to be drawn from all the evidence obtainable is that the sea mussel is not only as palatable as the oyster, but is the cheapest and most nutritious shellfish which can be placed on the market.

Efforts to induce the American people to eat mussels are now being made by several firms which are meeting with varying success. A packing company in Maine put samples of the canned and pickled shellfish on sale in a number of the New England cities, but although attractively put up in glass jars they were undersized, of poor quality, and had evidently been sterilized at too high temperature, which resulted in a decomposition of the protein into compounds which gave the product a disagreeable flavor. The project naturally met with poor success and no further attempt to put goods on the market was made during the past year.

One of our largest oyster companies has also taken an interest in the commercial possibilities of this mollusk. They have put out splendid samples of it in the form of *pickled mussels, deviled mussels* and *mussel cocktail* such as you see here on exhibition. The materials used are of finest quality and they are put up in a most attractive manner. If the goods taste as well as they look I predict a bright future for them. The president of the concern, however, speaks of them in a pessimistic tone. The company has been at considerable expense to get out these samples, but the result has been nothing more than favorable reports as to their quality and flavor; no orders

of any importance have been received. The people do not like their color and general appearance, and show a general prejudice against them without being able to give any reason for it. It will require a campaign of education to teach the public what it is missing by refusing to utilize this vast source of food supply.

The most encouraging news has been received from a Brooklyn dealer who during the past year has sold 50,000 bushels in either the fresh or pickled form. This is equivalent to double the value of the salt water mussel industry reported for the entire nation in 1908. His report further states that the business is growing and that a market is beginning to develop for them inland. His products are of superb quality and flavor, samples of which you will find here for examination. Other concerns with whom I have not been able to get in touch are marketing mussels in one form or another, but chiefly in the fresh condition, or pickled in vinegar and spices. Quantities of the shellfish are usually to be found on sale in Fulton Market. The demand for mussels in New York reached such a stage this past year that one Brooklyn firm complained it could not get its needed supply for pickling purposes.

Prejudice is a slow barrier to overcome, but the outlook is favorable for a gradual development of a sea mussel industry which will not stop until it has reached the same plane it now occupies in Europe, second only to that of the oyster.

DISCUSSION

PROF. PRINCE, Commissioner of Fisheries of Canada: Dr. Field has expressed surprise that the mussel is not more utilized for food. It *is* a matter of great surprise that this delicious mussel is not in greater demand. I have eaten very few mussels since coming to this continent, although I much prefer them to oysters or other shell-fish. They can be prepared in various ways for which the oyster is not suitable. As soon as people become accustomed to eat the mussel I believe it will take the first place as an edible shellfish. In London alone about fifty or sixty thousand tons are sold annually for food.

Apart from this, the mussel is the most important bait used by the fisherman. The Scotch fishermen use forty or fifty thousand tons per year for bait, and it is one of the most interesting spectacles for a traveler at a fishing village to see the dexterity with which the fisherwives bait the lines with mussels.

I am astonished that our fishermen do not use mussels more frequently instead of clams and various fish. The mussels are such an attractive bait, especially for cod, haddock and such fish, that the development of this industry is well worthy our efforts to promote.

Many years ago I was Secretary of the Mussel Commission of the British Islands and visited various mussel beds on the continent of Europe, and saw something of the methods of cultivation. The British coast is much exposed and artificial beds are carried away by storms, so we had to resort to transferring the young mussels to other localities where they could find food to grow into marketable size. The bed system and methods of artificial culture are a little too expensive on this side and in Britain. There is a lot of handling, and labor is expensive. I wish Dr. Field would explain why they still continue it in France and make it pay.

DR. I. A. FIELD: The reason they can carry on the bed system in France is because both labor and material are particularly cheap in that region. Furthermore the mussels grow large and at a phenomenal rate and bring the best prices, I think, of any mussels growing along that coast.

PRESIDENT: I find my neighbors on the Connecticut coast do not use them much. There is a fine bed near me on the Sound, but it is entirely neglected except by my own family. During a voyage of the Albatross we found the Indians about the Straits of Magellan living chiefly on the large mussel, *Mytilus chilensis*, which average five or six inches. Our whole ship's company of eighty persons feasted on these wonderful mussels which were eaten steamed.

PROF. WARD, of Illinois: Is the shell of these salt-water mussels utilized for commercial purposes?

DR. I. A. FIELD: I think there is a commercial use for it in the form of chicken feed. In addition to the lime it contains about 8% of albuminous material in the adult (16% in the year-old shell). If that albuminoid material can be digested by hens there is no reason why it cannot be converted into eggs.

MR. LYDELL, of Michigan: Has anyone tried this mussel, by grinding it up, as food for young bass or any other fish we are attempting to raise? We have been experimenting with the meat of the fresh water mussel from the button factories. We have been very successful so far with young bass, and I hope to report upon the matter in another year. We have also fed them whole to the large bass which appear to be very fond of them.

PRESIDENT: The Chair can answer Mr. Lydell's question in part. There is no doubt that nearly all kinds of fishes are fond of mussels. At the New York Aquarium the salt water mussel has been used along with other molluscs. Some fishes are especially fond of crushing the shells of the smaller ones.

ALEWIFE FISHERY OF MASSACHUSETTS

By G. W. Field,
State Commissioner of Fisheries and Game, Boston, Mass.

In Massachusetts the decline of the alewife (*Pomolobus pseudoharengus*) or "branch or river herring" fishery has for several years demanded the attention of the Department of Fisheries and Game.

During the past two years, a biological survey of the various streams in the State has been undertaken with the view of determining the present conditions, and what methods could promise the successful re-establishment of a fishery directly valuable to the shore towns, but indirectly of still greater value to the public. It is upon the result of this work that I desire to speak concerning the past and present conditions in the alewife fishery of Massachusetts.

Ever since the landing of the Pilgrims, the alewife fishery has been closely related to the progress or poverty of the shore towns. The fishery not only supplied food and fertilizer for the early inhabitants, but proved of great value (though that fact is even yet unappreciated) in attracting the large schools of fish such as pollock, blue fish, striped bass, squeteague, mackerel and other food fish, to our shores. With the decline of the alewife fisheries, due to various causes, notably unwise legislation leading to excessive fishing and the inroads of "civilization," there has been a corresponding decrease in the entire shore fisheries which demonstrates that the success of the fishing towns of our coast is dependent in considerable measure upon the condition of the alewife fishery. Conditions at the present time warrant the statement that by proper handling and restriction the fisheries of many streams can be brought back to their state of former abundance.

Natural History of the Alewife.—The alewife or branch herring is a member of the great herring family or *Clupeidae* and belongs to that class which ascends the tidal rivers for the purpose of spawning. It has

even become landlocked in the lakes of New York, although essentially a salt water species. The common names of this species are Branch Herring, Spring Herring, Alewife in New England with the modification of Ellwife or Ellwhop in the Connecticut River, Big-eyed or Wall-eyed Herring in the Albemarle River, Grayback (to distinguish it from the Blueback or Glut Herring (*P. aestivolis*) which arrives after the alewife), and Gaspereau in Canada.

The alewife is found along the Atlantic coast of the United states from Nova Scotia to Virginia, the range being from the Gulf of St. Lawrence to Cape May. In former days practically all the Massachusetts tidal rivers and streams were populated with this species of fish; but owing to the intervention of man the alewife has been extirpated in many localities and enormously diminished in all.

The spawning season in Massachusetts varies from year to year, but may begin as early as March and extend even until early June, during which period the alewife ascends the fresh water streams to the ponds at the head of the stream to spawn, and returns during May and June to the ocean. The eggs, measuring one-twentieth of an inch in diameter, adhere to each other and to various objects in the water. They are fairly hardy and survive conditions that would be fatal to the eggs of more susceptible fish. It is reported that falls and dams exceeding 2½ feet high prevent the passage of these fish to the spawning ground. On the other hand they readily mount fish ways of various types, selecting the greater current. In Massachusetts two classes of spawning grounds are found: (1) the ordinary brook or river with a tidal estuary into which empties fresh water, which rises in springs, ponds or lakes in many instances several miles from the ocean; and (2) the typical fresh water shore pond, lying close to the salt water, separated only by a narrow sand beach with a natural, shifting or artificial opening. The alewife fisheries on Martha's Vineyard are in ponds of this type.

Through artificial openings the alewives enter, during the spawning seasons, directly into the ponds from the salt water.

The alewife increases rapidly in size in the fresh water ponds, and by late summer obtains an approximate length of from two to four inches, when it descends from the breeding ground to the ocean, unless prevented by artificial structures such as cranberry bogs, dams, etc.

Little is known of the subsequent life of the alewife. It is commonly supposed that the same alewife will return three or four years later as a full grown fish to the same stream for the purpose of spawning. This is what is known as "the parent stream theory," and is in all probability, correct, although positive proof is difficult to obtain. Upon this assumption is based the plans for the future re-establishment of the alewife fishery, since by placing the spawning adult in the headwaters of the depleted alewife streams the fishery can once more be re-established. Where the alewife passes the period of its growth has not been definitely ascertained. It is probable that it remains in the deeper ocean water, but not far from the mouth of the stream whence it descended.

History of the Fishery.—In the early colonial records mention is made of the alewife as providing food for the first inhabitants of New England. At this time the fisheries were free and the supply greatly in excess of the needs of the population. Every inhabitant who was "a householder had the right of free fishing and fowling in any of the great ponds, bays, coves, and rivers so far as the sea ebbs and flows within the precincts of the town where he lived unless the freemen of the same town or the general court had otherwise appropriated it." Captain John Smith in his description of New England as relating to the fisheries, particularly the alewife and the cod, said, "If a man worked three days in a season, he would get more than he could spend in the entire year if his expenditures were not excessive." Cod were then

worth ten shillings a hundred and the poor fisherman could take from one hundred to three hundred a day.

The alewife fishery in each town was early made a public town asset, and held for the inhabitants of that town. The fishery was either regulated by the selectmen and the "herring committee," or else was sold at auction or private sale to certain individuals for a stated sum with a proviso, e. g. that each inhabitant who so desired should be entitled to purchase one hundred fish at the price of one-half a cent apiece.

As long as the fish were abundant and the population small, there was no decline in the fishery, but with the increase in population and the encroachments of civilization the alewife fishery began slowly but steadily to decline until at the present time only a remnant of the former abundance remains. It is safe to say that, taken as a whole, the alewife fishery has deteriorated approximately 75% from the original condition, and that there are only a few streams in Massachusetts which produce anywhere near their normal yield.

The causes of the decline are as follows:

(1) *Over-fishing.*—In spite of the laws restricting the time of taking the fish to certain days, little judgment was used by the men in charge of the fisheries, as too many alewives were taken and too few allowed to pass the spawning grounds. An instance of this short-sightedness is shown by the following case where on one stream which passed through three towns the time of fishing was regulated to three days a week, but it was so arranged that the fish were taken at places and times in the week covering every day for the reason that each town had three different days for catching the fish. Any fish that succeeded in getting by the first town would likely be taken in their passage through the second town, and if not taken there the escaping survivors almost certainly met their fate in the third town.

(2) *Dams.*—Obstructions to the streams by dams prevented the passage of fish to the spawning grounds. In all cases the laws explicitly stated that satisfactory pas-

sageways for the fish should be made over all dams, but in spite of the enactment and intent of these good laws, they were either evaded or defied by the mill owners with the result that in three-fourths of the alewife streams there are, at the present time, from one to three dams without suitably equipped fishways for the passage of the alewives.

(3) *Cranberry Bogs.*—In southern Massachusetts the development of cranberry bogs along the alewife streams with the frequent dams and obstructions have proved a serious drawback to the success of the alewife fishery, as the cranberry industry has been considered of more value than the fishery, and the owners have not been required to provide suitable passageways for the fish. The profits of the cranberry bogs are usually sufficient to warrant a reasonable outlay in maintaining the rights of the fisheries.

(4) *Other Obstructions.*—In spite of laws, private persons have placed various obstructions in the different streams which have prohibited the passage of the alewives to their spawning grounds.

(5) *Deforestation and Pollution.*—The pollution of the streams from manufacturing sources has likewise proved detrimental to the life and passage of the fish, and many streams already reduced in volume as a result of deforestation are temporarily ruined for the shad and alewife fisheries by the quantities of chemicals and other poisonous substances which have been turned into the water.

(6) *Laws.*—Legislative remedies, first applied in 1741, have been cumulatively restrictive and unsystematic rather than constructive, and few attempts have been made to restock or replenish the supply of fish at the spawning grounds. The aim of past legislation has been rather to restrict the catch than to increase the production,—a fundamentally wrong economic principle. Future legislation should be on both types, constructive as affects replenishment of the various streams, and restrictive only in such measure as to ensure the best results from the restocking. On the whole, the legis-

lation relative to the alewife streams when not, as often, confusing and conflicting, has been good, and if the provisions of the laws could have been adequately enforced by the towns assuming such responsibilities, there would probably have been little or no decline in the fishery. Unfortunately, the provisions of many excellent laws were not enforced and the result was the same as if no laws were upon the statute books.

Results of Annual Sales.—Very early the plan of leasing the fisheries to the highest bidders was instituted. This scheme has proved one of the most serious causes of the decline of the fishery. The leases were given for short intervals, frequently for one year, and the lessee endeavored to get all he could out of the fishery for the year without considering the future welfare of the fishery. Thus, for instance, streams where originally the alewife fishery was sold for as high as three thousand dollars are sold today for a mere pittance of five dollars or are not worth selling at all.

Present Conditions.—During the past two years the condition of the alewife fishery in every coastal stream of the Commonwealth has been thoroughly investigated by the Massachusetts Commission on Fisheries and Game, and the streams which are worth reclaiming have been noted. The conditions at the present time are deplorable. In most instances the towns take little or no interest in the fishery, and are perfectly willing to let the industry pass away. In other cases, the towns jealously guard their rights over the alewife streams, but in most cases do not show any desire or aptitude to improve the conditions, but strenuously object to outside interference, especially on the part of the State. It can fairly be said that the alewife fishery at the present time is in a deplorable condition, and if this State asset is to be saved, radical and immediate action on the part of centralized State control is essential.

Value of the Fishery.—The special value of the alewife arises from the fact that it is one of the few fish that "furnishes its own transportation"; coming in the early

spring to the very doors of the poor people. In the small streams, it is easily caught without expense, and has been used in the past not only for food but for fertilizer and has well paid. Within my recollection, in the Merrimac River, shad and alewives were used as fertilizer by the farmers in the immediate neighborhood. Today rarely does a single shad enter the river and the alewives are very few. This has been brought about by pollution in the manufacturing sections and by the large dams upon the river.

Alewives are still used considerably for bait and are a valuable asset. Twenty or thirty vessels come annually to Edgartown, each taking forty thousand alewives for bait. The value of the fishery to a town may in favorable seasons run as high as four or five thousand dollars. The organized companies average about 15% profit on the capital invested in addition to the fact that they distribute a considerable amount of money in wages among worthy people.

The situation is made the more imperative for the reason that the shad, which formerly came with the alewife to these same streams, and which by identical methods, conditions and causes have been practically exterminated, by the wise, patient and effective methods of the U. S. Bureau of Fisheries have been re-established in many streams, to the great economic advantage of the nation. Common sense methods applied to the alewife fishery will assist greatly in making possible again an annual catch of shad in Massachusetts waters. But after all, the greatest value of the alewife fishery is one that is little considered by the average person, viz., the value of the alewife as a food for the larger fish which frequent the Massachusetts waters. The small alewife in the fresh water ponds not only furnishes a source of food to the bass, pickerel, and other fresh water fish, but when it descends to the ocean it attracts to the vicinity of the streams large quantities of bluefish, squeteague, pollock, and other fish which prey upon both the small alewife and the adult. We have lost sight of

the fact that these alewives are an important fish as a means of attracting the other marketable fish to the whole Atlantic shores, and one cause of the decline in the shore fisheries can be attributed to the destruction of the alewife fisheries in the coastal streams. Therefore, there is firm ground for the opinion that the alewife fisheries, far from being solely a town asset, or even of concern to this State alone, are in fact an important national asset, and as such should be subject to Federal regulation for the benefit of all the fish consumers of every State in the Union whither fresh or prepared sea fish are shipped from the coastal States.

The Remedy.—The solution of this problem lies entirely, in my opinion, in Federal or at least in State control as distinct from town control. Restrictive legislation is not a rapid and economical method for increasing the quantity of fish, but almost invariably, in my experience, restricts the demand without increasing the supply. Two things are absolutely essential for the development of the alewife fishery. The first is that a sufficient quantity of alewives get to the spawning ground at the head waters of the stream by removing all obstructions to or by providing suitable devices for the passage; secondly, placing spawning alewives or eyed eggs in ponds at the head waters of the streams to re-establish fisheries which have become extinct. The regulation of the fisheries must be conducted in such a manner that the right proportion of the fish be allowed to pass up the stream to the spawning ground. This can only be done by people who are interested in the welfare of the fishery, rather than in getting all the money they can from the fishery. The fishery should be taken from the hands of the selectmen who have proved incompetent or too busy to handle the problem, and placed in the hands of a competent State board which could regulate the fishery by a scientific and uniform system both as regards stocking and removing of obstructions, and the correct regulations for the future development of the fishery. If the fishery is to be sold to the highest bidder, the term of years should be extended to at

least ten in order that the purchaser should develop the fishery and not work it for all that is in it.

Not only people in the shore towns but all the fishermen along the coast and the entire body of consumers are interested in the alewife fishery and in the consideration of a question which is not merely confined to the coastal streams and the shore towns, but extends to the entire fisheries of the State and even far beyond to the interests of the fisheries of the nation.

NOTES ON THE MONTANA GRAYLING

By W. M. Bickford,
Montana State Fish Commission, Missoula, Mont.

It is possible that a word concerning the Montana Grayling may be of interest, especially when considered in connection with its introduction by artificial propagation into waters tributary to the Pacific Ocean. The Grayling which for gameness is not surpassed by the trout, and so far as flavor on the table or beauty in the stream is concerned, is hardly equalled by any fresh water fish, is native to the waters of northern Michigan, Montana (in the upper branches of the Missouri river) and Alaska in the streams tributary to the Yukon.

There is such a close resemblance between the species found in Michigan, Alaska and Montana, that it is hardly necessary to enter upon a discussion of the slight differences in structure, although they are recognizable, and the Montana Grayling is given a rank of its own. The fish was first noticed in Montana and described by Lewis and Clark in the report of their trip of exploration to the Pacific in 1803, and later was classified by James W. Millner of the United Fish Commission.

Until Dr. James A. Henshall, at that time Superintendent of the United States Fisheries Station at Bozeman, Montana, undertook to raise the grayling, no effort had been made to stock streams with this very desirable game fish.*

The efforts toward artificial propagation were not at first successful, but with the patience and skill of a vetern, Dr. Henshall, after two or three efforts, succeeded, and between the years 1898 and 1907, distributed 17,343,026 fry and fingerlings from the Bozeman station.

So far as is known none of these fish were planted in streams flowing into the Pacific. It was not until the State of Montana established its hatchery at Anaconda,

*Seth Green hatched and reared Michigan Grayling at Caledonia, N. Y., in 1874.

that any effort was made to stock streams other than those in which the grayling was native.

In 1909 the State Fish Commission of Montana obtained a quantity of grayling eggs and planted over one million fry in Georgetown Lake, which is located on the headwaters of Flint Creek, which flows toward the Pacific.

For two years, nothing was known as to the result of the planting, but at the end of this time fishermen reported catching grayling in Georgetown Lake, but only in small numbers. The third year many were caught, some of them weighing two pounds and over, and at the end of two years and a half reports were received that grayling weighing in the neighborhood of five pounds had been caught in this lake. As the fish rarely reaches a weight of two pounds in its native habitat the large size of those caught can only be accounted for on the theory that the water temperature and food supply in Georgetown Lake are both favorable to large growth. The State Fish Commission has thus succeeded in planting the grayling in at least one stream which flows westward to the Pacific and the success attained encourages further efforts in this direction.

That the fish have taken kindly to their new home is shown by the fact that during the spawning season of 1913, they entered the two inlets to this lake in great numbers to spawn. At one time there were held in the traps set for catching them, over eleven thousand of spawning age, from which were taken about fifteen million eggs which were handled in the hatchery at Anaconda, but with only partial success. The fry, which resulted from the eggs taken, were many of them planted in other streams on the west side of the Rocky Mountains and favorable results are hoped for.

In 1910 there were planted in the Bitter Root River, about fifty thousand grayling fry, and in 1911 and 1912 other plantings were made, but so far no results have been noticed. While reports are at times received that

grayling have been caught, no specimens have been submitted for examination.

The Bitter Root River is a large fine trout stream and seems an ideal home for the grayling, and much interest is manifested in the result of the planting. Nothing could be more successful than the stocking of Georgetown Lake, hence the hope for similar results elsewhere.

To those who know and have fished for the grayling, or who have tasted its delicious flesh the stocking of suitable streams with this fish is a matter of much interest. The Montana waters which are profusely supplied with this fish are the Madison, Jefferson, Gallatin, Red Rock and Bighole Rivers, and many of the lakes found at the heads of these streams are also well supplied.

Should the details with reference to the propagation of the grayling be desired, attention is called to Bureau of Fisheries Document No. 628, where full information is given. It is the belief of the writer that an effort should be made to stock streams along the Atlantic seaboard with this fish.* They multiply rapidly, have all the game qualities of the trout, are unexcelled as a food fish and to the sportsman are a source of great pleasure, because they take the fly readily and make a game fight.

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*The experiment was made long ago in New York and abandoned. Montana Grayling were planted in Sunapee Lake, N. H., in 1904, 1906 and 1907, but Mr. W. C. Kendall (Bureau of Fisheries Document 783, 1913) states that there is no evidence of any success. Conditions appear to be unfavorable in our waters.—*Editor.*

THE FISH TRADE ORGANIZATIONS

By Frederick F. Dimick,
Secretary, Boston Fish Bureau, Boston, Mass.

The purpose of this paper is to present to the visiting members a brief outline of the work that is being done by the principal trade organizations of this city.

The Boston Fish Bureau was organized in June, 1875, in order to collect information relating to the fishing industry, to preserve statistics for reference, to discuss in a friendly manner and to act jointly on all matters pertaining to the fish trade.

It aims to secure reliable news in regard to the arrival, sale, catch and shipment of fish. This information is published in bulletins, from three to six daily, that are delivered to resident members by messengers, and to non-resident members by mail. In these days when reliable facts and figures enter largely into the successful prosecution of any business, the value of the Bureau is obvious.

Interest in the Bureau has grown steadily until its membership comprises the larger part of the salt fish, fresh fish, canned goods and lobster trades of our city and with them the leading merchants in Gloucester, New York, Philadelphia, Providence, Albany, St. Louis and Halifax.

The rooms of the Bureau are commodious and centrally located. Here are kept on file the weekly and yearly reports, the reports of the United States Bureau of Fisheries, the Department of Fisheries of Canada, of Newfoundland and other governments, which have proved interesting and valuable to any and all seeking information.

The members of the press recognize the value of our reports and are frequent visitors to our rooms, and the principal material for their daily and weekly reports are furnished by the Bureau.

Its correspondents constitute the best recognized authorities in every city and town the entire length of the American and Nova Scotia coasts, where fish are landed

and prepared for market. Recognizing the necessity of reliable information at the earliest moment, the Bureau has, in all eastern cities, correspondents who telegraph the moment a cargo is loaded, stating the nature and quantity. This enables the trade to know, twenty-four hours previous to the arrival of the goods, what may be expected, all of which has proved of great value.

The fishermen find the reports of the Bureau are an aid to them in locating schools of fish. It also informs them of places along the coast where they can obtain bait.

The New England Fish Exchange was organized in the year 1905 and has large and commodious quarters at the end of T Wharf, convenient for the dealers and fishermen. The purpose of the Exchange is to maintain a room for the purchase and sale of fish. The sales which were formerly made on the wharf are now all made in the room of the Exchange. It guarantees the consummation of all sales and purchases registered on the exchange, and is a sort of clearing house for the fresh fish trade.

The Exchange has improved the condition of the fresh fish industry, and a better feeling exists between the captains and the dealers. It aims to improve the sanitary conditions of the fresh fish trade of Boston. A credit association maintained by the Exchange has proven a valuable adjunct to the trade.

The Exchange has recently published a book entitled, "Recipes for Sea Food," which contains valuable information on how to preserve, prepare and serve fish; extracts from the fish and game laws, and other valuable information. The distribution of this book in the homes of the people and in the libraries ought to be a great benefit to the fishing industry.

The Boston Fish Market Corporation is a business organization that has charge of the leasing of wharf property occupied by the fresh fish trade. They are lessees of the new Commonwealth dock in South Boston, which is made entirely of cement, brick and glazed tile, thoroughly hygienic and fireproof. It provides dock berths

for forty vessels. The property contains an Administration building, cold storage and power plants, and two long buildings containing forty-four fish stores. The entire property comprises 537,100 square feet. Spur tracks on the property will make railroad facilities ample to all parts of the country. It is the best appointed and second largest fish market in the world.

The Boston Lobster Dealers' Association was organized last winter and has headquarters on Long Wharf. Here the lobster dealers have regular meetings during the lobster season and have made progress in bettering the conditions of the lobster trade. The special attention of this association is directed to the handling of the large quantities of lobsters which are received in this city from Nova Scotia.

The Fishing Masters' Association, as the name implies, is composed of the captains of the fishing fleet. They hold special meetings and take action on questions concerning their own welfare. A feature of this association is the publication annually of a book entitled "Fishermen of the Atlantic," which contains a list of the fishing vessels, and much other valuable information relating to the fishing industry.

A considerable number of those engaged in the fish trade are members of the Boston Chamber of Commerce, which has a membership of 4,000 and is a great factor in the civic and industrial progress of Boston and New England.

EXPERIMENTS IN FISH CULTURE

By Philip G. Zalsman.

Trout culture has been so much discussed that very little that is new remains to be said. I wish, however, to give the results of some experiments in crossing Brook, German Brown, Silver or Lake Tahoe, Rainbow and Lake Trout.* It is commonly supposed to be quite difficult to cross some species of trout, especially the rainbow and brook, but with the latter cross my experiments have been successful.

I have crossed brown trout eggs with brook trout milt and *vice versa*. These eggs did very well and some of them hatched out nicely, but I doubt if either cross will produce eggs or milt. Silver trout eggs were also crossed with brook trout milt, the resulting females producing eggs. In this cross the back of the fish resembles the brook trout, but the lower part of the body is similar to the silver trout.

Crossing rainbow trout eggs with brook trout milt also gave successful results, though I am not aware that this has been done before. In correspondence with the Commissioner of Fisheries I was informed that in their attempts to produce this cross at various stations "the results have been of a negative character." I also crossed the brook trout eggs with rainbow trout milt, but was not so successful, though I did raise some to the feeding stage. I was obliged to take the eggs in February from some stragglers, which of course were not so good as those taken in the earlier part of the season.

The following table gives some results of experiments in fertilizing brook trout eggs under various conditions:

	Condition of eggs.	Condition of milt.	Resulting hatch.
Experiment 1:	Fresh.	Fresh.	Good.
	After 15 min.	After 15 min.	15%
	After 1 hr.	After 1 hr.	0

*These experiments were carried on while in the employ of the Michigan and Wisconsin State Fish Commissions.

	Condition of eggs.	Condition of milt.	Resulting hatch.
Experiment 2:	After 5 min.	After 5 min.	25%
	After 1 hr.	Fresh.	10%
	Fresh.	After 1 hr.	0
Experiment 3:	After 1 min.	Fresh.	90%
	After 2 min.	Fresh.	80%
	After 3 min.	Fresh.	70%
	After 5 min.	Fresh.	40%
	After 10 min.	Fresh.	20%

These experiments show that unfertilized eggs live longer than milt at the same temperature, and that the sooner the milt is placed with the eggs the better.

If the temperature is too low the trout spermatozoa seem unable to enter the eggs for impregnation. If a little warm water is used when the air is cold at spawning time the eggs are fertilized more successfully, and this is especially true for the rainbow trout. The cross between the rainbow and brook trouts cannot be made successfully in cold water.

Eggs were taken from a ripe brook after it had been dead for an hour and a half, and fresh milt was added. About 5 per cent. of the eggs were impregnated.

A female and three male brook trout were taken in the spawning season and put in a tank by themselves. On November 2nd I took part of the eggs, again on the 5th and the balance on the 9th, using the three males every time. I could not see any difference in the impregnation of these eggs.

Some years ago, lake and brook trout were crossed by Mr. Marks, of Michigan. These females produced eggs and were again crossed with brook trout, making hybrids three-fourths brook trout.

Yearling brook trout, reared in a clay bottom pond covered with shades, were transferred to another station where they had sandy bottom and no shades. The bright sun shining on the sand caused the death of nearly all of them. The fish were curved up like a new moon or quarter-round. Shades should be provided for ponds with sandy bottom. I have known the sun to kill nearly all the fry in a box tank, when the cover was lifted on a bright day.

Fry hatched prematurely are not good. Care should be taken in transferring eyed eggs that the temperature does not get any warmer than the water from which the eggs were taken. Also the water feeding a hatchery should be kept at as constant a temperature as possible. A sudden rise or fall at hatching time will cause a premature hatch. These fry will live until they have outgrown their yolk sac and sometimes a week or two longer, but they do not seem to be able to feed and finally die.

(Many similar experiments in hybridization were made at Caledonia, N. Y., by Seth Green forty years ago. Hybrids between a large-scaled species, such as the rainbow and brook trout or other small-scaled species are sterile. T. H. Bean.)

SMALL-MOUTH BLACK BASS

By Charles H. Nesley, *Copake, N. Y.*

From the first day when I turned my attention to the culture of the small-mouth black-bass, I felt convinced that there was something radically wrong in the system used by most of the bass culturists in Pennsylvania and other states.

The matter I am now bringing before you is not the result of a sudden invention, but rather the work of devotion to the perfection of the culture of the small-mouth black bass.

In 1905, 1906 and 1907, I noted that the cribbing of bass was a waste of time, and in 1908 it was abandoned by the Department of Fisheries of Pennsylvania, then under the direction of the Hon. W. E. Meehan.

Under order of Mr. Meehan field work on black bass was started in Pennsylvania as early as 1906, in Wayne and Lackawanna Counties, with great success. It was there that I first found that larger bodies of water are not subject to the sudden changes of temperature which I have since found the worst thing to contend with in the artificial pond culture of black bass.

At the Torresdale, Conneaut Lake, Willow Brook and Hiram Peoples' hatcheries in Pennsylvania, black bass were being reared every year, but what did they cost? This is the point I am bringing before you for your consideration. Artificial pond culture of bass for breeding is not a success, nor has it ever been. All have some degree of success, but none can compete with the man who gets his bass in the larger lakes. I find that Pennsylvania has almost entirely abandoned the system of artificial pond culture. Some of the private hatcheries are still hanging on, but what Pennsylvania has done, I believe, is very practical. It gets its bass in the large lakes with less than one-tenth the cost. There are, of course, private hatcheries having no access to the natural lakes of Pennsylvania, but still there are many lakes owned by private parties in Pennsylvania and other

states that are just the right places to raise bass as a commercial enterprise.

For illustration, take Robinson Lake, owned by Mr. Ernest C. Brown, in Columbia County, New York. It is thirty feet deep and well stocked with bass. I personally counted over five hundred nests of the small-mouth bass. This year they started to spawn on April 22, and continued until the 18th of May, the temperature at this time being 56 degrees Fahr.

During a spell of six or eight cold nights, the temperature fell only three degrees. I went to Snider's Pond about a mile away, and there found that the temperature had dropped to 42. Here the eggs on most of the bass nests were dead and had been deserted, making them a total loss. Snider's Pond is shallow and subject to sudden changes in temperature while deeper lakes are not. I am sure that between 250,000 and 300,000 young bass could have been gathered in the first-named body of water. At this time the hatchery at Lake Waramaug was unable to fill the orders and the same condition was true at Hiram People's.

As Robinson's Lake is fairly well stocked with the Daphniae or "mijinko,"* the shipping of bass, as advanced fry, could be done directly from the lake with practically no expense. There is no hatchery account to be kept up, no mature bass to feed, therefore practically no outlay, nothing but gain. Field work may also be done in the same body of water for Yellow Perch, Rock Bass and Sunfish. All there is to it is the gathering of a reasonably sure crop every year, and no time is wasted in catching minnows to feed the larger bass.

In some of the states, New York for instance, the bass are not fed, but are taken in the spring shortly before spawning commences, which, for the sake of economy, I find practical. But the culture must be carried on in artificial ponds and hence is subject to any sudden change

*This is a Japanese term to include the minute crustacea such as *Daphnia, Cyclops,* etc., which form the natural food of many young fishes.—*Editor.*

in temperature. It is more practical, however, than the keeping and feeding of bass all the year round. I am satisfied from very close observation that when the bass are obtained by field work, the greatest part of the expense is saved, and that bass can be shipped and distributed from such sources at less than one-tenth the cost of artificial pond culture.

CONCERNING YOUNG BLUEFISH

By J. T. Nichols,
American Museum of Natural History, New York City.

It is my purpose to call attention to the value of having in museums extensive collections of the young of different fishes, and to the fact that such collections of young fishes are of prime importance in studying the habits of the species.

Unfortunately the American Museum of Natural History in New York has meager collections of such material, yet they will illustrate my meaning.

Young Bluefish, known as Snappers, abound in the inshore waters about New York in summer. They are extensively fished for with light rods for sport and food, and they are a most excellent panfish, tasting like the adult Bluefish, but sweeter and more delicate. To catch them, a light rod is used; the hook is kept usually two or three feet below the surface, baited with smaller fish alive or dead, *Fundulus* or *Menidia* generally preferred; but at times they bite voraciously on clam or worm bait.

Fishing commences in August, when the Snappers are about 4½ inches long (without tail fin). The Museum has specimens 4½ inches, Cold Spring Harbor, Long Island, August 12th; and 4¾ from the same locality in August. They grow rapidly and in September reach a length of 7 inches, with a weight of say 3 ounces. Specimens from Sandy Hook, October 8, 1897, are 6¼ and 7¼ inches long; one from the Hudson River, September 24, 1881, 7½ inches long.

On August 22, 1913, Dr. William H. Wiegmann of New York, found young Snappers being caught abundantly at Sheepshead Bay, and at the writer's request made measurements of 49 individuals. Five were 13 to 13.5 cm. (5¼ in.), six 16.5 cm. (6½ in.), eight 17 cm. (6¾ in.), thirty 17.5 to 18 cm. (7 in.) long.

The gap in sizes between the five smallest and the others is noticeable. In this connection we may note a similar gap in fish at Lloyd's Point, on July 30.

On August 18 to 20, at Prince's Bay, Staten Island, seven fish 4½ to 5 inches long were obtained by the writer, and others of about the same size observed. It will be noticed that these agree very well in size with the smaller ones at Sheepshead Bay of a corresponding date.

It is reported that on September 7 many Snappers were taken at Prince's Bay about 6 inches in length, but the Sheepshead Bay fish were mostly larger, for Dr. Wiegmann measured about 100 there on August 30 with average size 18 cm. (7 in.).

On July 30, 1913, the writer found small Snappers 1⅝ to 2 inches long, swimming in close-ranked schools like mullet or herrings, at Lloyd's Point, Long Island. In the water they looked distinctly silvery and deep, with dark ends to their tails. A small detachment rather close in to the gravelly shore was rounded up with a minnow seine, and about forty little fish all about of a size captured, verifying the identification of the others that had been seen. At this date there were also a few larger fish, perhaps 3½ inches long, in smaller companies much swifter and wider ranging, already beginning to strike at the regulation bait. Probably there is a marked change in habit at about this age. Well-preserved material which would admit of critical stomach examination would make this easy to determine, but unfortunately our Museum does not possess such material at present.

In past years the writer has seen a few much smaller fish, probably less than an inch in length, occurring singly in sheltered waters on the ocean side of Long Island, near New York. These were weak-swimming, and easy to capture, like baby trout or salmon in the shallows at the edges of the streams where they breed,—fishes which a little later are leading a more active and predaceous life in the channels of the same streams. Unfortunately he has now no specimens of these smallest Bluefish preserved from which accurate dates and measurements could be obtained.

The evidence, however, is clear that the Bluefish spawns off our shores in early summer, and there is material to show the growth of the young while with us.

According to Dr. G. Brown Goode, "American Fishes," 1888: "The Hon. Robert B. Roosevelt records that he observed the Bluefish fry less than an inch in length in the inlet of Far Rockaway, N. Y., on the 10th of July . . . . Dr. Yarrow does not give any facts in regard to this subject, at Fort Macon, except that spawn was seen to run out of a small female caught July 14th . . . . The only positive evidence . . . . is that of Capt. Pease, who states it as the general impression about Edgartown that they spawn about the last of July or the first of August. He has seen them when he thought they were spawning on the sand, having caught them a short time before, full of spawn, and finding them afterward for a time thin and weak. He thinks their spawning ground is on the white sandy bottom to the eastward of Martha's Vineyard, toward Muskeeget."

Dr. Tarleton H. Bean, writing in the report of the New York Forest, Fish and Game Commission for 1900, gives a detailed statement of the sizes of young Bluefish in Great South Bay in the summer of 1901. He says, "The smallest individual taken in July measured 3⅛ inches. In the first half of September the lengths varied from 3⅝ to 7¼ inches. Young Bluefish 7¼ inches long were caught in August . . . . a single young bluefish 7½ inches long was seined in the foot portion of Swan River, September 9."

It will be seen that these sizes agree very well with those given above, but show a wider variation. Probably the former give a fair idea of the average of the schools.

There is also material to show that the season is earlier further south. In the Museum collections a single specimen 4½ inches long, from Cape Sable, Florida, February 9, 1910, and five 3 to 3½ inches long, from Marco Pass, Florida, February 15, 1910, indicate that it is five months earlier in Florida.

In conclusion we may deduce the following generalizations, subject to much indefiniteness and some uncertainty, from our scanty evidence:

In the latitude of New York, the Bluefish spawns in early summer. The young are less than an inch long in early July, two inches long by the first of August, five to seven inches (with say 3 ounces weight) by September; and the season is earlier further south.*

*Young Bluefish, taken abundantly in the traps off Sea Bright, N. J., Sept. 20, 1913, ranged from 6¾ to 10 inches in length.

THE ATLANTIC SALMON

By Chas. G. Atkins,

U. S. Bureau of Fisheries, East Orland, Me.

The Atlantic Salmon (*Salmo salar*) occupies a very prominent place in the ranks of the species that have been the subjects of artificial propagation. Inhabiting naturally nearly or quite every river tributary to the Atlantic, north of the 43d degree of latitude on the European side and of the 40th degree on the American side, it has attracted attention of fish culturists in those countries where modern fish culture had its birth and has been most earnestly pursued. Its culture has been pursued in all the countries of northern and western Europe as far south as France and on the western side in Canada and the United States.

The life history of the Atlantic salmon has been much studied, and the following may be considered as well established: Passing the winter and early spring within the egg in a fresh water stream and very slowly developing, it bursts the shell in the spring, early or late, according to location, and then passes a year or two in its native river, attaining at the end of two years, a length of about 8 inches. It then goes down to the sea, where it stays several years, returning to its native river when full grown, weighing 8 lbs. or more, to deposit its eggs. In the rivers of Canada, as in those of the British Islands, great numbers of the salmon come in when they weigh only from 2 to 6 lbs., at which stage they are termed "grilse," but they rarely enter the rivers of Maine at this stage of growth.

The "run" of salmon in the Penobscot river begins in April and continues through May and June, and a few come in in July, or even later. If able to pass the obstructions in this river they ascend to various distances, many of them more than a hundred miles from tide water, and lie there until late in October, when they begin to spawn, the female digging holes in the gravelly bottom of the rapids and covering the eggs with gravel. A male at-

tends each female, fertilizing the eggs after they are laid and meanwhile chasing away all intruding fishes. The embryos begin their development at once and continue all winter, hatching for the most part in April.

The first spawning of a Penobscot salmon is apparently at the age of four years and a half. She then returns leisurely to the sea, generally reaching it the next spring or early summer, in a very emaciated condition, in consequence of total abstinence from food during the whole period of her stay in fresh water. She now resumes feeding and rapidly recovers condition, and, after a full year in the sea, is ready to ascend the river again to spawn a second time. In a few cases it doubtless happens that the fish makes a third visit to the river, thus laying three lots of eggs during her life. The facts pertaining to the return of the salmon for a second spawning were ascertained by experiments at Bucksport and Orland between 1872 and 1880, when a total of over 1,200 salmon of both sexes were marked on their release after spawning. The mark was in the form of a small aluminum tag attached by a fine platinum wire to the rear margin of the main dorsal fin, each tag stamped with a number which referred to a record showing the date of marking, the sex of the fish, its length and weight, and, if a female, the quantity of eggs yielded. The fishes bearing these tags were released in November in tide-water and doubtless in nearly all cases soon went out to sea. A year from the next spring and summer a few of them were recovered through the salmon fishermen of the Penobscot, with the tags still in place, when in every instance, it was found that the fish had fully recovered from the emaciated condition in which it had been dismissed, and had made an increase in weight and length over the condition when first handled. Out of the 1,200 marked, nearly 40 were recovered. This is a small percentage and it is entirely probable that far more than that number survived and returned without the tags, and possibly in some cases the tags escaped notice by the fishermen. Indeed, it may be regarded as remarkable that, with the fish almost con-

stantly in motion for so many months, and the tag swinging back and forth, the fine wires did not cut their way out from the margin of the fin in all cases.

The culture of this species of salmon now conducted at the Craig Brook station has for its prime object the maintenance of the species in the Penobscot river, which alone furnishes the material on which the work is based. The first step is the collection of breeding adults, which has thus far been done on their first appearance in the river when bound for their spawning grounds. In the lower part of the river and about its mouth a large number of weirs are each year built of stakes, brush and netting for the capture of salmon and alewives. Arrangements are made with a large number of weir fishermen to save their salmon alive, for which purpose they are supplied with soft nets, boxes and cars. For cars, common fishing dories are used; openings in their sides permitting the free ingress and egress of water when they are in motion, gratings at the openings and a cover of netting preventing the escape of the fish. Once a day near low water a motor boat traverses the fishing district and tows all the cars containing salmon up Orland river to a point in a fresh water tributary, Dead Brook, where there is constructed an enclosure occupying the entire stream for about a third of a mile in length, the width averaging about two rods and the depth ranging from four to twelve feet. Here the salmon are placed with free range through the enclosure. The collection is begun about May 20 and generally closed some time in June, several hundred salmon—sometimes more than a thousand—being collected. No food is offered them, and it is not believed that they would accept any if offered. There seems no doubt that it is their habit to abstain from food wholly during their stay in fresh water. Early in the history of this work more than a hundred stomachs taken at random from those cut up in the Bucksport markets, were saved and submitted to examination by experts in Washington, who could find nothing in any of them that appeared to be food or the remnants of food.

It therefore seems that the salmon cease to eat before they enter the river.

In the Dead Brook enclosure the salmon seem to find an ideal abode, and the deaths among them during the season appear to be caused by serious wounds received in capture, or, as sometimes happens, by excessively high temperature of water in July or August. Meanwhile their reproductive organs undergo a normal development and about the 20th or 22d of October the most forward of them are ready to lay their eggs. When they reach this condition they try to find swift water and, working up the stream, are entrapped at the head of their enclosure, dipped out and manipulated. When the salmon are collected, no attempt is made to distinguish between the sexes, but it has always turned out at the spawning season that the females are more numerous than the males. A rough shed shelters the workmen and here the eggs are taken and fecundated and packed on trays in which they are carefully conveyed to the Craig Brook hatchery, some two miles distant. Here the incubation is carried to the shipping point, and most of the eggs are then transferred for hatching to an auxiliary station at Little Spring Brook, a tributary of the East Branch of the Penobscot, situated about 120 miles above the mouth of the river. The fry hatched here are all liberated in the Penobscot river within a few miles of the hatchery, on the very grounds where they would have hatched naturally had their mothers been allowed to follow their natural instincts. A few of the eggs have sometimes been hatched at the Craig Brook Station and the resulting fry placed in the Penobscot or tributaries nearer the sea.

During the past ten years the number of young salmon artificially hatched and thus liberated in the Penobscot has been as follows:

Year	Planted in upper Penobscot, E. Branch	Planted in other Parts of Penobscot	Total
1905	727,462	289,102	1,016,564
1906	1,897,607	79,217	1,976,824
1907	2,156,852	39,830	2,196,682
1908	2,059,514	50,003	2,559,514
1909	647,790	24,430	672,220

Year	Planted in upper Penobscot, E. Branch	Planted in other Parts of Penobscot	Total
1910	1,299,779	155,609	1,455,388
1911	2,854,084	19,000	2,873,084
1912	1,841,221	22,711	1,863,932
1913	3,482,464	4,304	3,486,768

The adult salmon in store at Dead Brook are sufficient to justify a result for 1914 fully equal to that of 1913.

The effect of this work on the product of the salmon fisheries of the Penobscot is shown by the statistics of the catch in the counties of Hancock, Penobscot, Waldo and Knox, collected by the Maine Commissioner of Sea and Shore Fisheries. The total catch in these counties for several years was as follows:

Year	Catch of Salmon in lbs.
1905	52,368
1906	41,202
1908	33,425
1909	26,125
1910	56,730
1911	98,680
1912	86,240

Thus the catch for 1911 and 1912 far exceeds that of any other two years. The catch for 1911 is confidently stated to have been the best for 20 years. These are very encouraging figures and as the artificial work has of late been on a somewhat larger scale than formerly, the prospect of eventual success is very cheerful.

BUILDING AN AQUARIUM FOR PHILADELPHIA

By W. E. Meehan,
Director of the Philadelphia Aquarium.

After fifteen years of agitation, the City Councils of Philadelphia passed an ordinance directing the establishment of a Public Aquarium. The ordinance was signed by the Mayor, John E. Reyburn, May 16, 1911. By its terms the old Fairmount Water-works buildings in Fairmount Park, near the Spring Garden Street Bridge and on the banks of the Schuylkill River were designated as the site of the new institution.

The Fairmount Water-works were built in the first quarter of the last century, and for many years were famous over this country and Europe for the completeness of the plant and for the beauty of the buildings. They were situated below the Fairmount Dam, with a huge rocky hill, known as Faire Mount, as a picturesque background on the east. The water-works plant was abandoned by the city of Philadelphia in 1910.

There were two power houses, one 200 feet long and 50 feet wide, and the other 100 feet long and 50 feet wide; and these it was proposed to utilize for the new Aquarium. They were admirably adapted for the purpose, requiring no radical structural changes. As the roofs are flat and used as a plaza, by the public, it is a simple matter to install the necessary overhead skylights which are to illuminate the tanks.

It is planned to use the smaller of the two buildings as a sea water house and the larger as a fresh water house, and possibly for sea water fishes also. The two buildings will hold approximately 140 capacious tanks.

A small sum, about $1,500, was appropriated in December, 1911, with which to establish a temporary aquarium of fresh water fishes in the large hall of a building once used for administration purposes by the Water Department at the Fairmount water works. In the general plans for the permanent aquarium this large hall is designated by ordinance of councils to be used for the de-

livery of public free lectures on aquatic animal life. The building in which the temporary aquarium was installed is unsuited for exhibition purposes, and the tanks available not proper for a good or permanent display of fishes. They had belonged to the State and were used by it at the Expositions of Chicago and St. Louis.

The temporary aquarium was installed by me in three weeks, and it is still in operation and visited by about 6,000 people weekly. The first year of its existence there were over 260,000 visitors. Twenty-seven tanks and about that many species of fresh water fish comprise the exhibit.

No work has been done towards the completion of the permanent aquarium since October, 1912, when the sea water house was within about six weeks of completion. The funds provided for the completion of the sea water house and possibly the fresh water house are embodied in a municipal loan authorized last winter, but which will not be available until about October, 1913, perhaps not then.

The tanks in the sea water house will be made of concrete and the majority of them will be seven feet long each, and one 12½ feet.

Lead lined pipe or hard rubber pipe is almost universally in use for conveying sea water to and from tanks, but lead lined pipe very frequently does not give perfect satisfaction, and hard rubber pipe is exceedingly expensive. After mature deliberation I determined to try the experiment of testing the utility of wood pipe. A four-inch pipe of that material for the supply pipe is now in place, and five-inch wooden pipe for the out-flow will be used, together with terra-cotta.

I can see no reason why wooden pipe should not be as efficient as hard rubber and much better and safer than lead lined pipe. It certainly will not corrode, nor leak, and it has been in successful use for more than 30 years in the oil regions for conveying salt water from the oil wells and it is used almost exclusively in the coal mining

regions for conveying mine water impregnated with sulphur.

The sea water house abuts directly on the Fairmount Dam. Owing to the liability of floods from the Schuylkill River it was necessary to raise the floor above the ordinary flood level; therefore in that building there will be but one set of tanks. The fresh water house will have a second tier of tanks making the capacity of that building 110 tanks of large size.

OYSTERS, A DESIRABLE FOOD

By Henry C. Rowe, *Groton, Conn.*

The "high cost of living" has become a familiar phrase in recent years, but familiar phrases frequently lose their significance because the public mind notices and remembers only what is novel and recent. But the high cost of living is more than a phrase; it represents a stern fact which to many of us is imperative and to all is certainly a problem of great public concern.

The United States and territories are so vast in their extent and resources that a few years ago it seemed that this country was and would remain the chief source of food, clothing, lumber, fuel and minerals for a large portion of the world, but our doors were opened so wide to the crowded millions of other lands that already consumption in certain lines has increased far beyond production and by wasteful methods, luxurious living and other well-known causes, we are brought face to face with this problem. It will insist upon recognition until we find adequate remedies and adopt them.

Among other items the demand for food is imperative. We all know that food has increased vastly in price. Here are some of the figures within a few years:

	Increase
Fresh eggs	26.1 %
Sirloin steak	59.5 %
Roast beef	63.8 %
Fresh milk	32.9 %
Pure lard	55.3 %
Smoked hams	61.3 %
Round steak	84. %
Creamery butter	33.3 %
Hens	58.1 %
Corn meal	63.7 %
Pork chops	86. %

These figures show that some of these foods have become too expensive for constant or frequent popular use. Fortunately there are other foods just as nutritious, wholesome and palatable as are the more expensive, which a large portion of the population can no longer afford to have.

While other foods have so greatly increased in price, oysters can still be furnished at no higher price than many years ago. This is due to the great extension of the artificial propagation, growing and cultivation of oysters. Then, too, the quality of the oysters furnished to the consumer has greatly improved. The improved methods of cultivation, refrigerating and shipping have been a great benefit to the oyster product and they are now in every way more desirable to the consumer than years ago.

Another great advantage in delivering this product is that the transportation is greatly extended and has become more efficient, so that oysters, either opened or in the shell, can be furnished in perfect condition in all parts of the United States and Canada where the railroads penetrate.

Still another very important feature concerning the oyster industry is the fact that the sensational attacks made within a few years upon the wholesomeness of oysters have been discredited by the highest scientific and official authorities on this continent. Dr. Carl L. Alsberg, Chief of the Bureau of Chemistry at Washington, has given special consideration to this subject and says, "I could wish that the number of dangerous sources of milk supply was as small and that the percentage of pure wholesome milk was as great as the proportion of wholesome, safe oysters that reach our tables," and if his opinion needed any support it might be found in the public utterances of other men of the highest authority upon these subjects, as, for instance, Dr. Earle Phelps, Prof. Sedgwick, Dr. Julius Nelson, Dr. Frederick P. Gorham and others.

The prejudice which was instilled in the minds of many timid people has never extended to those persons who are well informed concerning the oyster industry, but it has influenced many of those who are readily impressed by sensational statements of "food demagogues" and by the lurid headlines of the yellow press.

In the paper which I presented to the International Fisheries Congress in 1908, I called attention to the vastly increasing production of oysters and to the importance of this economical, wholesome and palatable food. Since that time the need of such a substitute for meat has greatly increased and the proof of the wholesomeness of oysters has become conclusive. The prejudice which existed for a time has been shown to have had a most trifling foundation in fact and that so far as life and health are concerned there is far more danger in riding on a railroad train, or in a motor car, or even in walking the street where motor cars abound, than there is in eating oysters every day; also, that oysters are far more wholesome and safe than water or milk. We do not hesitate to use water or milk; we only insist that they shall be kept pure and in perfect condition. That is now all that intelligent people require concerning oysters.

For this reason I ask your aid in placing before the public the facts; that the vast increase of the supply of oysters by reason or their artificial propagation; the improved methods of refrigerating and shipping them, and the wholesomeness, palatability and economy of oysters as food, should commend them as a frequent substitute for those foods which have so greatly increased in price during the past ten or fifteen years.

SUGGESTIONS OF POSSIBLE INTEREST TO THE AMERICAN FISHERIES SOCIETY AND TO FISH COMMISSIONS

By Wm. P. Seal, *Delair, N. J.*

I. Argument in favor of certain modifications of the Fish Protective Laws.

In papers read before the American Fisheries Society, the writer has expressed the opinion that there is not the general sympathy that there should be with the objects of this society, the prevailing sentiment being that the laws enacted for fish protection are inspired largely by anglers wholly in the interest of sport. It is the desire here to call attention to one phase of discrimination embodied in fish protective legislation that from the viewpoint of many persons interested is not only unjust but also unwise since it affects a class of men who might possibly become a valuable auxiliary force in the general interests and progress of fish culture.

There are now in the United States seven aquarium societies with a large membership of men of scientific inclinations, and others are projected. There is a monthly magazine devoted to their pursuits published under their joint auspices by members of the societies.

There is in progress in the United States a *renaissance*, so to speak, in the use of the aquarium as a scientific instrument for nature study. Large numbers of beautiful and interesting species of fishes are constantly being imported from Germany, where they are being bred, to which country they have been brought from remote parts of the earth, but many of them from North, Central, and South America, and even the United States.

The illustrated catalogs of the ornamental fish breeders and dealers of Germany are an astounding revelation of our lack of progress in this direction. In the United States we have a great many beautiful and interesting species, especially adapted to the aquarium, which are not of the slightest value commercially and many of

which have no value even as food for the commercial or sport species, but on the other hand are to a greater or less extent destructive to the young of such, and of their food. But, even if they were valuable in some respect or other, the numbers of them that would be taken for scientific purposes—which would properly include aquarium stock—would be relatively so small as to be insignificant. Dr. Theodore Gill once said to the writer, "It is a shame that we know so little of our commonest fishes." And in his paper, "A Plea for the Observation of the Habits of Fishes, and Against Undue Generalization," read before the Fourth International Fishery Congress, he says, "We have still much to learn about our most common and longest known species."

Surely if there is any value in nature study, the observation of our fishes should rank as high as any other phase of it and should receive, at least, encouragement from those most directly interested—the fish culturists and the fishermen. Yet, without a restricted permit, which but few are able to get from the various state fish commissions, an aquarium fancier may not catch a pair of 4-spined sticklebacks for observation, and yet this is one of the most insignificant and absolutely worthless species from any other viewpoint than that of nature study, but from that one of the most interesting. In the State of Pennsylvania the holder of a permit is required to make a report at the end of the year specifying the use he has made of it.

It is apparent from a circular letter recently received from the President of the American Fisheries Society that there is an increasing lack of popular interest in the objects of the society as evidenced by an apparent loss of membership. Many years ago in a paper read before this society the writer outlined a plan of organization tending to popularize the society and the work of fish culture and fish protection. This was merely a suggestion which might or might not have proven practicable, but it was given merely for the purpose of stimulating consideration and discussion of the subject. But it ap-

pears to be impossible to overcome the purely selfish tendencies involved and until this is accomplished there will be no progress in this direction.

For many years a stranger listening to the discussions of the American Fisheries Society might have concluded that there was but one phase of fish culture of very great importance, with but one serious question involved, that known as "Fry vs. Yearlings." It will probably never be settled to the satisfaction of its opposing advocates.

It was quite apparent to the writer at the Fourth International Fishery Congress that the feeling was strong among the working fish culturists that too much prominence was being given to scientific and pseudo-scientific investigation, and perhaps even more to plain amateur observations such as interest the writer and others as becomes good citizens interested in problems affecting the general welfare.

The society has since then wisely differentiated its functions thus practically broadening its legitimate field of work, allowing full scope for the spirit of investigation as well as for encouragement of practical work. This course, if pursued with liberality, should lead to greater popularity for the society, without which it never will be progressive.

It is in this spirit and from this viewpoint that it is here suggested that there should be a modification of the fish protective laws in the interest of scientific investigators, nature students, and aquarium fanciers, to allow them to take fishes for their purposes. The schools, even down to the kindergardens, have aquaria, for nature study, but no legitimate means of supplying them.

The aquarium societies represent a class of citizens that should be in alliance and in sympathy with the general work of fish culture and fish protection, if only as creators of fish cultural sentiment. There is no such restriction, so far as known to the writer, in any other country and it is looked upon by those whom it affects as an arbitrary, selfish, and unjust misuse of power. There is no analagous feature in the laws for the protection of

birds or quadrupeds. Furthermore, such laws are a dead letter and always will be. But there is no reason why men should have to violate the laws to obtain what they are justly entitled to as well as are a favored few.

The writer is neither a fish culturist nor an angler, and is, of course, unable to comprehend the viewpoint of either, but he believes that a liberal policy on their part is necessary to a progressive development of their interests. Selfishness will not prevail in the future as it has in the past. The writer is not a member of any aquarium society and his personal interest would be opposed to a change in present conditions.

It is, from the writer's viewpoint, unfortunate that the great aquaria of the world would have not been planned in accordance with such principles as would render them of adequate value as aids to biological research. As adjuncts to biological laboratories they have value in the temporary holding of water life under conditions that can never be wholly satisfactory. In the matter of mechanical accessories they may be perfect, but for the actual elucidation by observation of the life histories of fishes they have not the necessary approximation of natural conditions and the results are meagre. They probably afford abundant opportunity for the study of the parasitic forms of life which are developed in greatest profusion under conditions unfavorable to higher forms. But the reports of such institutions show that the general results attained are not what are most desired from an epigenetic viewpoint. The investigations are more likely to be largely pathological than biological.

There is an increased interest in the development of public aquaria. It is, from the writer's viewpoint, unfortunate that the great aquaria of the world have not been planned with a view of making them of value as aids to biological research.* That has been a secondary consid-

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*This is true only of such institutions in the United States. The aquariums of Europe are almost without exception merely adjuncts to biological laboratories. See Kofoid, Biological Stations of Europe, U. S .Bureau of Education, Bull. 4, 1910.—*Editor.*

eration, and whatever knowledge of aquatic life has been gained through them has been by some accidental development of favorable conditions.

It seems to the writer that there should be some way found under Government or other auspices to systematically record such observations in the interest of ichthyology and for the encouragement of a popular interest in fish-culture. Those who have the greatest opportunities do not seem to be able to take advantage of them, but, as a matter of fact, there is little encouragement for it. A reading of "How we encourage research" in "Impressions of Theophrastus Such" (George Elliot) is recommended to all who have scientific aspirations.

The term "rational development" as applied to the establishment of aquaria in this paper means simply the nearest possible approximation to natural conditions, or in other words an endeavor to render fishes measurably contented and happy so that they will continue healthy and perform their natural functions. This we easily do with small species in small aquaria and by simply establishing similar conditions on a large scale we can get the same results with larger species. The writer explained the general principles involved in a paper entitled "The Aqua-Vivarium as an Aid to Biological Research," which was published in the Bulletin of the United States Fish Commission for 1885.

While fully realizing the probable uselessness of making suggestions it is the hope of the writer that some fish-cultural Moses with the wisdom and prescience of a Baird will one day arise and lead in a progressive development of such work. Our present ideals are not beyond those of the ancient Romans—the spectacular. And until we get beyond menagerie methods there will be nothing better. A popular development of the household aquarium will do much to effect a change. Exhibits of bruised, diseased, or half-starved specimens of either land or water life are only disgusting and depressing to a well-balanced mind. Some day public sentiment will condemn exhibitions of animals except in a healthy contented condition.

It appears to have been fairly demonstrated that rod and gun clubs and fish and game protective societies cannot alone be depended on to foster a popular support for progress in fish-culture. Greater liberality and greater publicity such as are revolutionizing the methods of agriculture are what is needed. The present Commissioner of Fisheries has for some years been practically alone in promoting popular publicity—relating to fish culture and fisheries.

The National Geographic Society is an example of what can be accomplished in the building of a society by liberal and efficient management. It has not, like the Fisheries Society, a great economic value to uphold it, but only scientific sentiment, and yet men are proud of the honor of membership in it.

II. Advocating the stocking of the rivers of the Eastern United States with pearl mussels.

Notwithstanding the wide range and extent of the investigations relating to pearl mussel industry by the United States Bureau of Fisheries recording a threatened destruction of the industry through extinction of the mussels, the writer has seen no mention of any movement to stock the waters of the eastern United States with them. East of the Alleghenies are many noble rivers with hundreds of tributaries which should be well adapted to them and which could be easily stocked. The writer has a shell of one of these mussels which he took from the Little Miami River and which is seven inches long and five inches broad with a maximum thickness of about three-quarters of an inch.

It is evident that in pursuing this industry there is a large economic waste that possibly might be prevented by drying the meat of the mussels and grinding it for food for fowls.

The same idea might also be applied to certain marine life that is either wasted or is not taken for want of a market which the poultry industry might possibly supply.

III. Argument in favor of co-ordination of fish culture and protection, conservation of waters, and mosquito extermination.

There are three lines of public work which are at present carried on independently, two of which are as yet only in the first stages of development, which in due course of time it will be found necessary to co-ordinate. These are: 1, fish culture and fish protection; 2, conservation of water supply; and 3, mosquito control, all of which involve problems relating to control of the waters of the country.

President Wilson, when Governor of New Jersey, called attention to the desirability of reducing the number of state boards and commissions in the interests of economy and efficiency. As at present conducted, in many cases, instead of co-operating they work at cross purposes.

Conservation of water supply certainly has a direct bearing both on fish culture and on the mosquito problem, for whatever waters are restored or conserved should be devoted as an economic consideration to the breeding of food fishes. They should therefore be under control of the fish commissions. Having control of the waters, it should be their function to destroy or prevent the breeding of mosquitoes in them.

The basic idea in mosquito extermination is drainage, in some cases, to destroy breeding places, and in others—in tidal regions—to allow the ingress of schools of minnow mosquito destroyers. All this is more or less effective. But it is a question in the mind of the writer whether more consideration should not be given to the possibilities of impounding waters wherever possible instead of resorting to drainage.

It must be apparent to anybody at all familiar with any one of the water sheds in any part of the country that there is an increasing diminution of the flow of springs and small streams as the result of deforestation. This is well understood and our conservation and forestry commissions are striving with all the power that is

given them to check this evil. But, already in the State of New Jersey experiments in irrigation are being made, as a result of recurring severe spring and summer droughts affecting the crops.

Would not it then be the part of wisdom to increase by impounding, instead of decreasing by excessive drainage, the extent of our water areas?

It is probable that most of the swamp or marsh land recovered by drainage will never be available for cultivation, or only at excessive cost, while if made into ponds and lakes wherever economically possible, it would provide increased means of adding to our fish food supply as well as additional opportunity for pleasurable recreation and sport.

It is well known that mosquitos are not bred in the larger bodies of water where there are numerous fishes to destroy their larvae. It is the insignificant puddles and pools—the rain pool in particular—that supply them. And this is the case even on the salt marshes. And these insignificant places are very difficult to destroy. In a swampy, boggy place small quantities of water are always present no matter how much draining is done. It will bubble up from springs, the tracks of a cow, horse, or a man will fill, especially after heavy rains, and as it requires only five days to produce a crop of mosquitos the chance of absolutely exterminating them is small, and the work of keeping them in check must, under such conditions, go on continuously and permanently.

These are questions that might profitably be discussed by the American Fisheries Society, for if it is desired to add to its importance and popularity it must necessarily interest itself in whatever practical questions arise, with regard to the waters, that may have a bearing on the general welfare.

Otherwise other societies will arise to promote such work, working perhaps at cross purposes with those interested in fish culture. Sooner or later these questions will have to be considered. The question of efficiency as well as utility in public work is growing in importance.

It is absolutely necessary in the interest of increased and economical food production, which is rapidly becoming the most vital of all questions.

Whether it is wiser for this society to anticipate and lead to the controlling of events that are certain to occur at some time in the future or to postpone all consideration of them until opposing forces have grown more powerful is a question worthy of thought.

If, however, the American Fisheries Society is to remain always an association of fish culturists pure and simple, solely dependent for support on the sporadic and ephemeral enthusiasms of rod and gun clubs and the fishery interests, nothing more need be said. The trifling question of dues has no bearing on the possibilities of accomplishment open to this society through a progressive course. Those of the National Geographic Society are no greater. But look at the membership, 200,000 to a few hundreds. Why is it so?

An optimistic outlook might even forecast the gradual evolution of a great "Department of Conservation" in which would be co-ordinated bureaus of "Conservation of Forests and Waters," "Fish Culture, Fish and Game Protection and Fisheries" and "Biological Research," to cover investigations concerning life of economic value or destructiveness.

LISTS OF MEMBERS, 1913—1914

Showing Year of Election to Membership

Honorary Members

The President of the United States, WOODROW WILSON.
The Governors of the several states.
Alabama, EMMET O'NEAL.
Arizona, GEORGE W. P. HUNT.
Arkansas, GEORGE W. HAYS.
California, HIRAM W. JOHNSON.
Colorado, ELIAS M. AMMONS.
Connecticut, SIMEON E. BALDWIN.
Delaware, CHARLES R. MILLER.
Florida, PARK M. TRAMMELL.
Georgia, JOHN M. SLATON.
Idaho, JOHN M. HAINES.
Illinois, EDWARD F. DUNNE.
Indiana, SAMUEL M. RALSTON.
Iowa, GEORGE W. CLARKE.
Kansas, GEORGE H. HODGES.
Kentucky, JAMES B. MCCREARY.
Louisiana, LUTHER E. HALL.
Maine, WILLIAM T. HAINES.
Maryland, PHILIP L. GOLDSBOROUGH.
Massachusetts, DAVID I. WALSH.
Michigan, WOODBRIDGE N. FERRIS.
Minnesota, ADOLPH O. EBERHART.
Mississippi, EARL BREWER.
Missouri, ELLIOTT W. MAJOR.
Montana, SAMUEL V. STEWART.
Nebraska, JOHN H. MOREHEAD.
Nevada, TASKER L. ODDIE.
New Hampshire, SAMUEL D. FELKER.
New Jersey, JAMES F. FIELDER.
New Mexico, WILLIAM C. MCDONALD.
New York, MARTIN H. GLYNN.
North Carolina, LOCKE CRAIG.
North Dakota, L. B. HANNA.
Ohio, JAMES M. COX.
Oklahoma, LEE CRUCE.
Oregon, OSWALD WEST.
Pennsylvania, JOHN K. TENER.
Rhode Island, ARAM J. POTHIER.
South Carolina, COLE L. BLEASE.
South Dakota, FRANK M. BYRNE.
Tennessee, BEN W. HOOPER.
Texas, O. B. COLQUITT.
Utah, WILLIAM SPRY.
Vermont, ALLEN M. FLETCHER.
Virginia, H. C. STUART.
Washington, ERNEST LISTER.
West Virginia, HENRY D. HATFIELD.
Wisconsin, FRANCIS E. MCGOVERN.
Wyoming, JOSEPH M. CAREY.

'08 ANTIPA, PROF. DR. GREGOIRE, Inspector-General of Fisheries, Bucharest, Roumania.
'06 BESANA, GIUSEPPE, President of the Lombardy Fisheries Society, Via Rugabella 19, Milan, Italy.
'09 BLUE RIDGE ROD AND GUN CLUB, Harper's Ferry, W. Va.
'93 BORODINE, NICHOLAS, 10th Linie 5, St. Petersburg, Russia.
'12 CALDERWOOD, W. L., Inspector of Salmon Fisheries for Scotland, Edinburgh, Scotland.
'04 DENBIGH, LORD, Colonel of the Honorable Artillery Company, London, England.
'89 FISH PROTECTIVE ASSOCIATION OF EASTERN PENNSYLVANIA, 1020 Arch St., Philadelphia, Pa.
'04 FRYER, CHARLES E., Supervising Inspector of Fisheries, Board of Agriculture and Fisheries, London, England.
'04 HOFER, PROF. DR. BRUNO, Biological Research Station for Fisheries, Munich, Germany.
'04 KISHINOUYE, DR. K., Imperial Fisheries Bureau, Tokyo, Japan.
'08 KITAHARA, DR. TASAKU, Imperial Fisheries Bureau, Tokyo, Japan.
'88 LAKE ST. CLAIR SHOOTING AND FISHING CLUB, Detroit, Mich.
'04 LAWRENCE-HAMILTON, DR. J., M. R. C. S., 30 Sussex Square, Brighton, England.
'04 MATSUBARA, PROF. S., President Imperial Fisheries Institute, Tokyo, Japan.
'09 NAGEL, HON. CHAS., St. Louis, Mo.
'95 NEW YORK ASSOCIATION FOR THE PROTECTION OF FISH AND GAME, New York City.
'08 NORDQVIST, DR. OSCAR FRITJOF, Superintendent of Fisheries, Lund, Sweden.
'01 PECK, HON. GEORGE W., Milwaukee, Wis.
'06 PERRIER, PROF. EDMOND, Director Museum of Natural History, Paris, France.
'92 SOUTHSIDE SPORTSMEN'S CLUB, Oakdale, L. I., N. Y.
'06 STEINDACHNER, PROF. DR. FRANZ, Royal Natural History Museum, Vienna, Austria.
'92 VINCIGUERRA, PROF. DR. DECIO, Director Royal Fish Cultural Station, Rome, Italy.
'06 VON GRIMM, DR. OSCAR, Inspector-General of Fisheries, St. Petersburg, Russia.
'08 VON KADICH, DR. HENRICH, Department of Forestry and Domain, Vienna, Austria.
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'13 KNIGHT, H. J., Alaska Packers' Association, San Francisco, Calif.
'10 KOPPLIN, PHILIP, JR., Missouri Fish Commission, Forest Park, St. Louis, Mo.

'03 LAMBERT, E. C., Amoskeag Mfg. Co., Manchester, N. H.
'03 LAMBSON, G. H., U. S. Bureau of Fisheries, Baird, Cal.
'11 LAND, S. E., Department of Game and Fish, Denver, Colo.
'04 LAUMEN, FELIX A., U. S. Bureau of Fisheries, Mammoth Springs, Ark.
'08 LAY, CHARLES, Sandusky, Ohio.
'98 LEACH, G. C., U. S. Bureau of Fisheries, Yes Bay, via Ketchikan, Alaska.
'12 LEAVITT, PERCY W., P. O. Box 374, Akron, Ohio.
'13 LEE, HARVEY S., 374 Washington St., Boston, Mass.
'10 LEE, W. MCDONALD, Commissioner of Fisheries, Irvington, Va.
'10 LEMBKEY, WALTER I., Woodward Bldg., Washington, D. C.
'02 LEWIS, CHARLES E., Chamber of Commerce, Minneapolis, Minn.
'10 LINTON, DR. EDWIN, Washington & Jefferson College, Washington, Pa.
'06 LOCHER, WM., Kalamazoo, Mich.
'00 LOCKE, E. F., U. S. Bureau of Fisheries, Woods Hole, Mass.
'12 LOESCH, H. C., Colorado Springs, Colo.
'13 LOWELL, CARLETON W., U. S. Bureau of Fisheries, Fairport, Iowa.
'98 LYDELL, DWIGHT, Michigan Fish Commission, Comstock Park, Mich.
'10 LYDELL, MRS. DWIGHT, Comstock Park, Mich.

'10 MABIE, CHARLES H., Maywood, N. J.
'13 MACCALLUM, G. A., M.D., 981 Madison Ave., New York, N. Y.
'11 MCDONALD, CARL K., U. S. Bureau of Fisheries, Neosho, Mo.
'03 MCDOUGAL, J. M., Gunnison, Colo.
'13 MCINTYRE, DOUGLAS N., Deputy Commissioner of Fisheries of British Columbia, Parliament Bldg., Victoria, B. C.
'13 MCLAIN, W. S., Bellefourche, S. Dak.
'12 MCREYNOLDS, B. B., Water Superintendent, Colorado Springs, Colo.
'03 MAHONE, A. H., U. S. Bureau of Fisheries, Quilcene, Wash.
'80 MALLORY, CHARLES, Port Chester, N. Y.
'12 MALONE, EUGENE, State Fish Hatchery, Henderson, Colo.
'10 MANNFELD, GEO. N., Indianapolis, Ind.
'97 MANTON, DR. W. P., 32 Adams Ave., West, Detroit, Mich.
'11 MARDORF, H. F., 4068 Olive St., St. Louis, Mo.
'11 MARINE, DR. DAVID, Western Reserve University, Cleveland, Ohio.
'13 MARIS, JAS. D., 324 W. 14th St., Indianapolis, Ind.
'98 MARKS, H. H., Sault Ste. Marie, Mich.
'98 MARKS, J. P., Michigan Fish Commission, Paris, Mich.
'99 MARSH, M. C., 113 High St., Buffalo, N. Y.
'06 MARTY, JOHN M., Minnesota Fish and Game Association, St. Paul, Minn.
'12 MASON, C. C., Hermit, Colo.
'13 MATHEWSON, E. P., Anaconda, Mont.

'00 MATHEWSON, G. T., Thompsonville, Conn.
'84 MAY, W. L., 314 Nassau Block, Denver, Col.
'00 MEAD, DR. A. D., Brown University, Providence, R. I.
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'11 MERRIHEW, PERCY T., Neosho, Mo.
'13 MERRILL, ARTHUR, Wilkinsonville, Mass.
'12 MERRILL, BERTRAM G., Illinois Fish Conservation Society, Hinsdale, Ill.
'99 MERRILL, M. E., U. S. Bureau of Fisheries, St. Johnsbury, Vt.
'13 MERSHON, W. B., Saginaw, Mich.
'11 MEYER, GUSTAV J. T., 833 South Delaware St., Indianapolis, Ind.
'11 MILES, GEO. W., State Commissioner of Fisheries and Game, Indianapolis, Ind.
'02 MILLER, FRANK, Ohio Fish and Game Commission, Put-in Bay, Ohio.
'08 MILLER, FRANK M., President Board of Commissioners for the Protection of Birds, Game and Fish, 605 Maison Blanche Bldg., New Orleans, La.
'10 MILLETT, ARTHUR L., Gloucester, Mass.
'00 MILLIGAN, DR. J. D., Woods Hole, Mass.
'92 MILLS, G. T., Chairman State Fish Commission, Carson City, Nev.
'11 MINCH, HARRY C., U. S. Bureau of Fisheries, Fairport, Iowa.
'10 MINER, ROY W., American Museum of Natural History, New York City.
*'13 MIXTER, SAML. J., M.D., 180 Marlboro St., Boston, Mass.
'13 MONROE, OTIS D., Supt. State Fish Hatchery, Palmer, Mass.
'13 MONROE, WM., Comstock Park, Mich.
'13 MOORE, ALFRED, 618 American Bldg., Philadelphia, Pa.
'99 MOORE, CHAS. H., Detroit, Mich.
'04 MOORE, DR. H. F., U. S. Bureau of Fisheries, Washington, D. C.
'05 MORCHER, GEORGE, London, Ohio.
'10 MORGAN, WM. E., U. S. Bureau of Fisheries, Edenton, N. C.
'92 MORRELL, DANIEL, Hartford, Conn.
'10 MORRILL, J. P., Verdi, Nev.
'04 MORRIS, DR. ROBERT T., 616 Madison Ave., New York City.
'10 MORSE, WM R., Manager International Fisheries Company, Tacoma, Wash.
'99 MORTON, W. P., Providence, R. I.
'10 MOSER, CAPTAIN JEFFERSON F., General Superintendent Alaska Packers' Association, San Francisco, Cal.
'08 MOWBRAY, LOUIS L., New York Aquarium, New York City.
'10 MUNLY, M. G., 1006 Yeon Building, Portland, Ore.
'13 MURPHY, C. H., Sabattis, N. Y.
'12 MUSGROVE, W. E., Leadville, Colo.

'13 NEAL, WALTER I., Maine Fish and Game Commission, Augusta, Me.
'73 and '10 NEIDLINGER, PHILIP, 2225 Emmons Ave., Sheepshead Bay, N. Y.
'08 NESLEY, CHARLES H., Copake, N. Y.
'86 NEVIN, JAMES, Superintendent Wisconsin Fish Commission, Madison, Wis.
'12 NEWCOMB, WILLIAM, Tenafly, N. J.
*'07 NEWMAN, EDWIN A., President Aquarium Fisheries Co., 4305 8th St., N. W., Washington, D. C.
'13 NEWPORT FREE LIBRARY, Newport, R. I.
'13 NEWPORT HISTORICAL SOCIETY, Newport, R. I.
'10 NICOLL, DONALD, 145 Bowery, New York City.

'10 NICHOLS, JOHN TREADWELL, American Museum of Natural History, New York City.
'13 OAKES, WM. H., 24 Union Park St., Boston, Mass.
'97 O'BRIEN, W. J., Supt of Hatcheries, Nebraska Game and Fish Commission, Gretna, Neb.
'13 OFTHSUN, T. O., Secy. Minnesota Fish and Game Commission, Glenwood, Minn.
'11 OGELVIE, E. L., Secy. Minnesota State Game and Fish Commission, South St. Paul, Minn.
'95 OHAGE, DR. JUSTUS, St. Paul, Minn.
'13 O'HARA, JOSEPH, Pleasant Mount, Pa.
'00 O'MALLEY, HENRY, U. S. Bureau of Fisheries, Oregon City, Ore.
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*'10 OSBURN, DR. RAYMOND C., Assistant Director New York Aquarium, New York City.
'12 OTIS, SPENCER, Railway Exchange, Chicago, Ill.

'13 PAGE, W. H., Sealshipt Oyster Co., Boston, Mass.
'12 PALMER, MARSHALL G., 96 East Ave., Kankakee, Ill.
'04 PALMER, DR. THEODORE S., United States Department of Agriculture, Washington, D. C.
'04 PARKHURST, HON. C. FRANK, Providence, R. I.
'07 PATCHING, FRED, Loring, Alaska.
'11 PATRICK, W. E., Supt. of State Fish Hatcheries, Denver, Colo.
'13 PATTERSON, A. G., Kentucky Fish and Game Commission, Pineville, Ky.
'02 PAXTON, THOMAS B., Board of State Fish and Game Commissioners, Cincinnati, Ohio.
'11 PELL, GEO. W., 520 16th St., Denver, Colo.
'05 PEOPLES, HIRAM, New Providence, Pa.
'10 PERCE, H. WHEELER, 904 Webster Bldg., Chicago, Ill.
'10 PEW, JOHN J., Gloucester, Mass.
'09 PFLEUGER, J. E., Akron, Ohio.
'12 PIERCE, HENRY L., Colorado Fish and Game Commission, Denver, Colo.
'10 PINKERTON, J. A., Superintendent State Hatchery, Glenwood, Minn.
'12 POE, S. S., Colorado Fish and Game Commission, Denver, Colo.
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'11 POHOQUALINE FISH ASSOCIATION, 233 Dock St., Philadelphia, Pa.
'09 POMEROY, GEO E., Toledo, Ohio.
'04 POPE, T. E. B., Milwaukee Public Museum, Milwaukee, Wis.
'06 PORTER, RICHARD, Board of State Fish Commissioners, Paris, Mo.
'09 POSTAL, FRED., State Board of Fish Commissioners, Detroit, Mich.
'12 POTEET, L. A., Deputy Warden, Florence, Colo.
'09 POWER, D. H., President State Board of Fish Commissioners, Suttons Bay, Mich.
'10 POWER, MRS. D. H., Suttons Bay, Mich.
'08 PRATT, DR. JOSEPH HYDE, State Geologist, Chapel Hill, N. C.
'10 PRICE, OVERTON W., National Conservation Association, Colorado Building, Washington, D. C.
'08 PRINCE, PROF. E. E., Dominion Commissioner of Fisheries, Ottawa, Canada.
'13 PURDUM, JAS. K. P., U. S. Bureau of Fisheries, Woods Hole, Mass.

'03 RACE, E. E., U. S. Bureau of Fisheries, Green Lake, Me.
'10 RADCLIFFE, LEWIS, U. S. Bureau of Fisheries, Beaufort, N. C.
'05 RANKIN, J. F., South Charleston, Ohio.
'84 RATHBUN, DR. RICHARD, Assistant Secretary Smithsonian Institution, Washington, D. C.

'93 RAVENEL, W. DE C., U. S. National Museum, Washington, D. C.
'13 REDWOOD LIBRARY, Newport, R. I.
'09 REED, DR. H. D., Cornell University, Ithaca, N. Y.
'12 REEME, E. W., Leadville, Colo.
'13 REIDEL, F. K., Pleasant Mount, Pa.
'93 REIGHARD, PROF. JACOB E., University of Michigan, Ann Arbor, Mich.
'13 REYNOLDS, JAS. A., U. S. Bureau of Fisheries, Woods Hole, Mass.
'13 RHINES, WALLACE D., Foreman, State Fish Hatchery, Linlithgo, N. Y.
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'10 RICKEMAN, GEO. W., Madison, Wis.
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'03 RIPPEL, ROBERT, Bayfield, Wis.
'12 RISER, DR. F. L., Henderson, Colo.
'13 ROACH, EDWIN R., 518 Hamilton Bldg., Akron, Ohio.
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'99 ROBERTS, A. D., Auditor Inland Fisheries Commission, Woonsocket, R. I.
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'98 ROGERS, J. M., Plaza Hotel, Chicago, Ill.
'99 ROOT, HENRY T., 266 Sackett St., Providence, R. I.
'13 ROSE, W. G., Grand Lake Stream, Me.
'98 ROSENBERG, ALBERT, Kalamazoo, Mich.
'11 ROTE, E. E., U. S. Bureau of Fisheries, Homer, Minn.
'10 ROWE, HENRY C., Groton, Conn.
'11 RUCKMAN, CHAS. W., U. S. Bureau of Fisheries, Homer, Minn.
'09 RUNION, H. P., Bankleman, Neb.
'13 RUSSELL, J. R., U. S. Bureau of Fisheries, Birdsview, Wash.
'13 RYAN, CALVIN D., U. S. Bureau of Fisheries, Concrete, Wash.

'13 SACHS, JAS. G., Pres. Kentucky Game and Fish Commission, 6th and Jefferson Sts., Louisville, Ky.
*'05 SAFFORD, W. H., Missouri Fish Commission, St. Joseph, Mo.
'05 SALMON, ALDEN, South Norwalk, Conn.
'13 SANTA BARBARA PUBLIC LIBRARY, Santa Barbara, Calif.
'12 SCHAEFFLE, ERNEST, Secretary California Fish and Game Commission, San Francisco, Cal.
'13 SCHLEICHER, R. O., Supt. State Fish Hatchery, Story, Wyoming.
'13 SCHWARTZ, BENJAMIN, Scientific Assistant, U. S. Bureau of Fisheries, Washington, D. C.
'11 SCHMITT, WALDO, U. S. Bureau of Fisheries, Washington, D. C.
'00 SEAGLE, GEORGE A., U. S. Bureau of Fisheries, Wytheville, Va.
'13 SEAGRAVE, ARNOLD, Woonsocket, R. I.
'10 SEAL, WM. P., Delair, N. J.
'00 SELLERS, M. G., 1518 Sansom St., Philadelphia, Pa.
'10 SHEBLEY, FRANK A., Superintendent Santa Cruz County Hatchery, Brookdale, Cal.
'13 SHELLFORD, VICTOR E., Associate in Zoology, Chicago University, Chicago, Ill.
'13 SHERWIN, GERALD, Lake Delaware, N. Y.
'91 SHERWIN, H. A., 100 Canal St., Cleveland, Ohio.

'10 Shields, G. O., 1061 Simpson St., New York City.
'11 Shinn, James A., Department of Game and Fish, Denver, Colo.
'11 Shira, Austin F., U. S. Bureau of Fisheries, Homer, Minn.
'08 Shiras, Geo., 3d; Stoneleigh Court, Washington, D. C.
'12 Shope, S. P., 941 Lawrence Ave., Chicago, Ill.
'10 Sieurin, P. G., Director Central Swedish Fish Hatchery Co., Kloten, Sweden.
'03 Simmons, Walter C., Providence, R. I.
'13 Singleton, J. Ernest, Woonsocket, R. I.
'01 Singleton, James H., Woonsocket, R. I.
'03 Slade, George P., 309 Broadway, P. O. Box 283, New York City.
'13 Smith, Herbert C., White Cloud, Mich.
'91 Smith, Dr. Hugh M., U. S. Commissioner of Fisheries, Washington, D. C.
'99 Smith, Lewis H., Algona, Iowa.
'05 Snyder, J. P., U. S. Bureau of Fisheries, Bozeman, Mont.
'11 Southall, John B., U. S. Bureau of Fisheries, Fairport, Iowa.
'12 Spargur, Robert L., Chief Clerk Colorado Fish and Game Commision, Denver, Colo.
'08 Speaks, John C., Chief Warden, Ohio Fish and Game Commission, Columbus, Ohio.
'12 Spencer, F., Provo, Utah.
'87 Spensley, Calvert, Mineral Point, Wis.
'12 Sperry, E. P., 126 South Euclid Ave., Oak Park, Ill.
'10 Stack, F. George, "Kamp Kill Kare," Raquette Lake, N. Y.
'13 Stapleton, J. J., Green Lake, Me.
'04 Stapleton, M. F., U. S. Bureau of Fisheries, Manchester, Iowa.
'00 Starr, W. J., State Board of Fish Commissioners, Eau Claire, Wis.
'03 Steele, G. F., Cornell, Wis.
'11 Sterett, W. G., State Game, Fish and Oyster Commission, Port Lavaca, Texas.
'03 Stevens, Arthur F., 227 West Grand St., Elizabeth, N. J.
'05 Stevenson, Chas. H., 511 Moffat Bldg., Detroit, Mich.
'12 Stivers, D. Gay, Butte Anglers Association, Butte, Mont.
'04 Story, John A., U. S. Bureau of Fisheries, Green Lake, Me.
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'88 Stranahan, J. J., Bullochville, Ga.
'13 Sullivan, Walter E., Marquette University School of Medicine, Milwaukee, Wis.
'04 Surbur, Thaddeus, U. S. Bureau of Fisheries, Fairport, Iowa.
'11 Swift, H. F., Swift-Arthur Packing Co., 16 Colman Dock, Seattle, Wash.
'10 Sword, C. B., New Westminster, British Columbia, Canada.
'10 Sylvester, Richard, Municipal Building, Washington, D. C.

'04 Talbott, Henry, Interstate Commerce Commission, Washington, D. C.
'13 Thaw, August B., 1421 Shelby St., Indianapolis, Ind.
'99 Thayer, W. W., U. S. Bureau of Fisheries, Northville, Mich.
'06 Thomas, W. H., U. S. Bureau of Fisheries, Fairport, Iowa.
'13 Thomas, Adrian, 2517 Hanover Ave., Richmond, Va.
'00 Thompson, W. P., 123 N. Fifth St., Philadelphia, Pa.
'00 Thompson, W. T., U. S. Bureau of Fisheries, Bozeman, Mont.
'08 Thomson, G. H., Estes Park, Colo.
'13 Tichenor, A. K., Secretary Alaska Packers Assn., San Francisco, Calif.
'13 Timson, Wm., Vice-President, Alaska Packers Assn., San Francisco, Calif.

'10 TIERNEY, JAS. N., Roxbury, Vt.
'92 TITCOMB, JOHN W., Commissioner of Fisheries and Game, Lyndonville, Vt.
'11 TONGUE, LEONARD M., U. S. Bureau of Fisheries, Washington, D. C.
*'01 and '12 TOWNSEND, DR. CHARLES H., Director New York Aquarium, New York, N. Y.
'13 TREXLER, COL. HARRY C., Allentown, Pa.
'13 TRIGGS, CHAS. W., 218 N. Canal St., Chicago, Ill.
'99 TUBBS, KRANK A., U. S. Bureau of Fisheries, Mammoth Spring, Ark.
'98 TULIAN, EUGENE A., Conservation Commission, New Court House, New Orleans, La.
'13 TURNER, CHAS. C., Judge Kentucky Court of Appeals, Frankfort, Ky.
'13 TUXBURY, CHAS., Windsor, Vt.
'13 TYSON, JAS. W., Connecticut Fish and Game Commission, Hartford, Conn.

*'11 VALLETTE, LUCIANO H., Chief of Section of Fish Culture, 827 Rivadavia, Buenos Aires, Argentina.
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'13 VARDEN, GEO. S., Paris, Ky.
'10 VILES, BLAINE S., Inland Fish and Game Commissioner, Augusta, Me.
'11 VIQUESNEY, J. H., State Game and Fish Warden, Belington, W. Va.
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'12 VOGT, JAMES H., Nevada Fish Commission, Carson City, Nev.
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'06 WADDELL, JOHN, Grand Rapids, Mich.
'96 WALKER, BRYANT, Detroit, Mich.
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'96 WALTERS, C. H., Cold Spring Harbor, N. Y.
'98 WARD, PROF. H. B., University of Illinois, Urbana, Ill.
'12 WARD, J. QUINCY, Executive Agent, Kentucky Game and Fish Commission, Frankfort, Ky.
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'92 WEBB, W. SEWARD, 44th St., and Vanderbilt Ave., New York City.
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'13 WELSH, WM. W., Scientific Assistant, U. S. Bureau of Fisheries, Washington, D. C.
'01 WENTWORTH, E. E., U. S. Bureau of Fisheries, Concrete, Wash.
'13 WESTERFELD, CARL, 854 Mills Bldg., San Francisco, Calif.
'13 WESTERMANN, J. H., Harrietta, Mich.
'01 WHEELER, CHARLES STETSON, Union Trust Building, San Francisco, Cal.
'04 WHITAKER, ANDREW R., State Fishery Commission, Phoenixville, Pa.
'96 WHITE, R. TYSON, 320 Bridge Street, Brooklyn, N. Y.
'10 WHITMAN, EDWARD C., Canso, Nova Scotia, Canada.
'89 WILBUR, H. O., 235 Third St., Philadelphia, Pa.

'99 WILLARD, CHARLES W., President Inland Fisheries Commission, Westerly, R. I.
'01 WILSON, C. H., Glen Falls, N. Y.
'11 WILSON, J. S. P. H., Chairman, Board of Inland Game and Fish Commissioners, Auburn, Me.
'10 WINCHESTER, GRANT E., Forest, Fish and Game Commission, Bemus Point, N. Y.
'00 WINN, DENNIS, U. S. Bureau of Fisheries, Oregon City, Ore.
'13 WINTER, J. H., Alaska Packers Assn., San Francisco, Calif.
'99 WIRES, S. P., U. S. Bureau of Fisheries, Duluth, Minn.
*'13 WISNER, J. NELSON, Director, Institute de Pesca del Uruguay, Punta del Esto, Uruguay.
*'05 WOLTERS, CHAS. A., Oxford and Marvine Streets, Philadelphia, Pa.
'97 WOOD, C. C., Plymouth, Mass.
'13 WOODS, JOHN P., President, Missouri State Fish Commission, 1st and Wright Sts., St. Louis, Mo.
'11 WORTH, HENRY B., U. S. Bureau of Fisheries, Washington, D. C.
'84 WORTH, S. G., U. S. Bureau of Fisheries, Orangeburg, S. C.
'10 WURZBURG, L., Ketchikan, Alaska.

'09 YERINGTON, EDWARD B., Board of Fish Commissioners, Carson City, Nev.
'10 YOUNG, CAPT. CARL C., 2 Mt. Vernon St., Gloucester, Mass.
'06 YOUNG, CAPT. JOHN L., Atlantic City, N. J.

'99 ZALSMAN, P. G., Comstock Park, Mich.

Recapitulation

HONORARY	75
CORRESPONDING	19
ACTIVE (including 30 life members)	611
TOTAL MEMBERSHIP	705

CONSTITUTION

(As amended to date)

ARTICLE I

NAME AND OBJECT

The name of this Society shall be American Fisheries Society. Its object shall be to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of all interests of fish culture and the fisheries, and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II

MEMBERS

Any person shall, upon a two-thirds vote and the payment of two dollars, become a member of this Society. In case members do not pay their fees, which shall be two dollars per year after the first year, and are delinquent for two years, they shall be notified by the treasurer, and if the amount due is not paid within a month thereafter, they shall be, without further notice, dropped from the roll of membership. Any person can be made an honorary or a corresponding member upon a two-thirds vote of the members present at any regular meeting.

The President (by name) of the United States and the Governors (by name) of the several states shall be honorary members of the Society.

Any person shall, upon a two-thirds vote and the payment of twenty-five dollars, become a life member of this Society, and shall thereafter be exempt from all annual dues.

Any library, sporting or fishing club, society, firm or corporation may, upon two-thirds vote and the payment

of the regular annual fee, become a member of this Society and entitled to all its publications.

Any person, society, club, firm or corporation, on approval by the Executive Committee and on payment of $50.00, may become a Patron of this Society with all the privileges of a life member, and then shall be listed as such in all published lists of the Society. The money thus received shall become a part of the permanent funds of the Society and the interest alone be used as the Society shall designate.

ARTICLE III

OFFICERS

The officers of this Society shall be a president and a vice-president, who shall be ineligible for election to the same office until a year after the expiration of their term; a corresponding secretary, a recording secretary, an assistant recording secretary, a treasurer, and an executive committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session —four to constitute a quorum.

In addition to the officers above named there shall be elected annually five vice-presidents who shall be in charge of the following five divisions or sections:

1. Fish culture.
2. Commercial fishing.
3. Aquatic biology and physics.
4. Angling.
5. Protection and legislation.

ARTICLE IV

MEETINGS

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or, in default of such action, by the executive committee.

ARTICLE V

ORDER OF BUSINESS

1. Call to order by president.
2. Roll call of members.
3. Applications for membership.
4. Reports of officers.
    a. President.
    b. Secretary.
    c. Treasurer.
    d. Vice-Presidents of Divisions.
    e. Standing committees.
5. Committees appointed by the president.
    a. Committee of five on nomination of officers for ensuing year.
    b. Committee of three on time and place of next meeting.
    c. Auditing committee of three.
    d. Committee of three on programme.
    e. Committee of three on publication.
    f. Committee of three on publicity.
6. Reading of papers and discussion of same.
    (Note—In the reading of papers preference shall be given to the members present.)
7. Miscellaneous business.
8. Adjournment.

ARTICLE VI

CHANGING THE CONSTITUTION

The constitution of the Society may be amended, altered or repealed by a two-thirds vote of the members present at any regular meeting, provided at least fifteen members are present at said regular meeting.